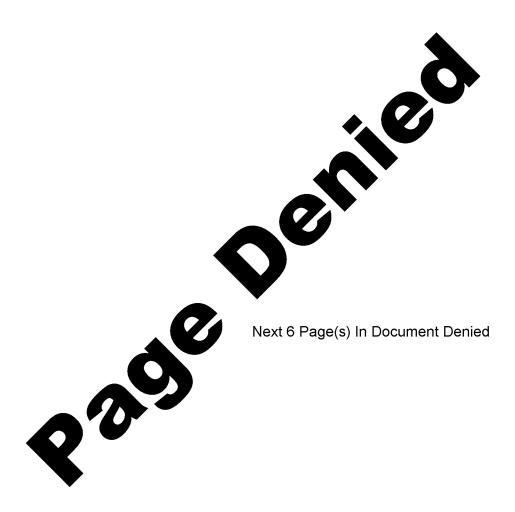STAT

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A CYCLONE HEAT EXCHANGER

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The coefficient of heat transfer through the walls of a cyclone, depending on the diameter and length of the apparatus, the form of the inlet nozzles and on the velocity and properties of the gases was studied.

When the gases entry through one or more inlet nozzles, the coefficient of heat transfer may be expressed by a simple function. Near to the exit of the nozzle, the heat transfer coefficient is up to 100 times higher than with tubes commonly used. The value of the heat transfer coefficient quickly decreases with the distance from the mouth of the nozzles.

A cyclone in the role of heat exchanger has many preferences comparing with tubular exchangers. It is preferably useful for preheating of thermolabil gases as well as for quick cooling of the product from chemical reactions.

BASIC PROBLEMS IN BOILING AND CONDENSATION PROCESSES FOR THE CASE
OF DIRECT HEAT REMOVAL FROM LIQUID REACTING SYSTEMS

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If the reaction heat is removed by internal evaporation of
the liquid reactant, the bulk boiling in the liquid body repre-
sents a special case of nucleate boiling with internal heat ge-
neration. Several questions relating to the origin and behaviour
of nuclei are discussed, especially for polymerisation systems with
homogenous and heterogenous catalysis. Also the influences of the
latent heat of evaporation and that of the hydrostatic pressure
are analysed.

The contribution to the mixing of the liquid due to bubble
formation and to bubble rise is examined and the mechanical work
done by rising bubbles is calculated and compared with that of
mechanical stirrers. The vapor velocity through the free liquid
surface was found to be the factor limiting the maximum permissible
reaction rate.

The function of the reflux condenser is a normal one, except
when the vapour is raising the liquid phase, mostly in the form
of a foam. An equation is derived for the latter case and the con-
ditions for reliable operation are reported.

Advantages and application possibilities of reaction heat
removal by internal evaporation are also referred to, especially
in heavy tonnage production of plastics.

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MIXING OF SOLID PARTICLES IN A FIUIDIZED BED

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A simple diffusion model for one-dimensional horizontal mixing of solid particles in a fluidized bed has been verified. Three methods were used for this purpose:

a/ providing of evidence for a relative stability of the value of diffusion coefficient in the course of a non-steady state diffusion process,

b/ a comparison with Poisson's partition of random distribution of diffusion coefficient values measured in a greater series of experiments carried out under identical experimental conditions,

c/ a comparison of experimentally established functional dependences of the diffusion coefficient upon some variables with dependences which were derived from physical conceptions connected with the diffusion model.

Results of the treatment of experimental data according to above-mentioned three methods do not rule out the applicability of diffusion mechanism for the description of this mixing process.

This study may be a contribution to the investigation of particles behaviour in a fluidized bed. In practice, the distribution of particles residence in a fluidized bed could be predicted, event. controlled in this manner.

A METHOD OF OPTICAL OBSERVATION OF STREAMING IN LIQUIDS AND GASES

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A method has been developed permitting direct observation of streaming in liquids and gases in apparatus made of glass or plastics, and in some cases even in production devices.

Small particles of fluorescent substance /especially purified anthracene/ are added to the liquid or to the gas under observation and made visible by a beam of ultraviolet rays. The movement of particles is recorded photographically and the velocity of their movement in certain direction may be read from the length of light trace. Thus, vector components of streaming in gas or in liquid in any section may be established. By combining vector components in two, or three directions, respectively, the determination of absolute values of direction and velocity of streaming in any point of the model is possible.

The method is demonstrated on several examples of streaming in liquids and gases, and some physical principles affecting its use are pointed out.

4

ABRASION OF PARTICLES IN A FLUIDIZED BED

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The application of fluidized bed technics is strongly
limited by abrasion of particles, especially in catalytic
chemistry. For a proposal of a reactor of optimum design,
knowledge is necessary of the dependence of particles ab-
rasion upon their size, the bed expansion, initial height
of the bed, and the diameter of the equipment. This paper
deals with the results of an investigation of the abrasion
of alumina particles in dependence upon dynamic properties
of a fluidized bed.

EXPERIMENTAL INVESTIGATION OF A QUASI-STATIONARY PROCESS

THEORETICAL FUNDAMENTALS OF A SIMPLE METHOD AND ITS APPLICATION
FOR LEVEL ESTABLISHMENT OF A MECHANICALLY AGITATED, EVENTUALLY
AERATED LIQUID

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If a random function should be followed in time dependence
with the aid of automatic recording, known difficulties arise
from mechanical and electro-dynamic inertia of equipment used.
In the case of a quasi-stationary character of this function,
the distributing function of its amplitudes can be determined
on the base of ergodic properties. This is an adequate inform-
ation on the behaviour of the system studied in many cases.

The method is based in the determination of relative
time intervals in the course of which the magnitude followed
attains values which belong to individual, mutually interconnec-
ted but not overlapping subintervals of its range.

In the case that the magnitude followed was the height of
the level point of mechanically agitated /event. aerated/ li-
quid, this principle has been applied on the base of electric
conductivity of the medium. The measuring circuit involved an
electrode which was immersed permanently in the agitated charge,
and a point electrode which was successively located in known,
adjustable positions along a range of height values, involv-
ing on its given place the vibrating level. An impulse coun-
ter recorded the time intervals during which the point immer-
sed in the liquid has been located in individual positions.
The total time of the experiment was also known. The measur-
ing procedure may be simplified considerably if the statistic
process followed takes a normal course.

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FLOW OF NON-NEWTONIAN FLUIDS

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Solution of differential equation for the flow of Ost-
wald-deWaele non-Newtonian fluid was carried out by the analogy
method and two forms of Reynolds number were obtained. These forms
were compared mutually and also with the form proposed by Metz-
ner. Applications of the three forms of Reynolds number were
compared according to critical values at the end of laminar
flow region, and experimental data obtained in measuring flow
rates of synthetic latices.

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DEHYDRATION OF CRYSTAL HYDRATES IN A FLUIDIZED BED DRYING UNIT

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In a laboratory discontinuous fluidized bed drying unit,
the course of dehydration of crystal hydrates has been follow-
ed. With drying temperatures where the tension of vapours above
the hydrate does not exceed the pressure in the drying unit,
time intervals which correspond to individual hydrates can be
distinguished on the drying curve. The drying process proceeds
very rapidly at higher temperatures. Time intervals of constant
drying rate are read off from drying curves at the start of
drying only.

In pilot scale continuous fluidized bed drying units, the
process of the drying of crystal hydrates has been followed at
temperatures where the vapour tension of the hydrate exceeds the
pressure in the drying unit. The character of dried substances
has been described. Technical and economic data are also given.

8

ON DESIGNING COLUMNS FOR NITRIC ACID PRODUCTION FROM NITROGEN OXIDES

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E. Kordish and I. Litvinenko
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Kharkov, USSR

Considerable acceleration of the absorption of nitrogen oxides by water solutions takes place in the sieve plates column. The velocity of nitric acid formation is controlled in dependence upon the pressure of oxidation reactions of nitrogen oxides and their interaction reactions with water.

The efficiency of plates in dependence on temperature, linear velocity and total pressure of nitrite gas as well as of acid concentration have been determined. The dependences giving the possibility to determine interplate distances at which minimum volume of column is obtained have been given.

The possibility of receiving nitric acid with the concentration of 68 - 70 % in zone absorber with sieve plates working at the pressure of 3,8 - 5 atm. has been set. The optimum sizes of holes and the free cross-section of column plates have been found. The degree of decreasing the expenses of the production in dependence upon the total pressure of gas has been determined.

The great importance of the oxidation process of nitric oxide and nitric acid in the production of concentrated nitric acid by the method of direct plant synthese from nitrogen oxides and water has been established. The best design of the permanent action autoclave is the plate-type or the sieve-type column with oxidizing space between the plates.

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GAS-LIQUID INTERACTION IN FOAMS

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Direct interaction betwwen gases and liquids, i.e. cool-
ing and heating of gases and liquids, evaporation of liquids,
drying and dampening of gases, absorption and desorption of
gases, etc. are greatly intensified if the treated gaseous-li-
quid matter takes the form of unstable foam. Active turbulence
results in a large continuously renewing interphase surface
and weak diffusive resistance. The apparatus operating under
foam conditions is termed a foam apparatus. This system pro-
vides for a far greater intensity of thermal and diffusive
processes than standard bubblers and scrubbers.

Foam treatment has lately found extensive application in
chemical and other industries. Foam equipment is particularly
widely used for purifying gases from dust and fog.

FLUIDIZED BED MINIATURE PILOT PLANTS IN INDUSTRIAL ORGANIC
CHEMISTRY

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The Institute of Industrial Organic Chemistry of the
Technical University of Dresden works in the field of chemi-
stry, the control of technical reactions, and unit processes,
concerning both education and research problems. Miniature pi-
lot plants have been developed, usedin experimantal courses
and for basic scientific problems. These small plants may be
conveniently installed in laboratory rooms. Plant equipment
allows determining data in chemistry, physical chemistry, and
unit operations. Results are required for preliminary design
and design of plants in chemical industry.

Models of small fluidized bed reactors were studied. In
several slides some types of reactors are shown. There are
simple models for laboratory use and automatic miniature pi-
lot plants with compplete recovery of fluidized catalyst. It
seems very important to calculate not only the characteristics
of the reactor but also to test and to develop the practical
equipment.

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POSSIBILITIES OF LARGE-SCALE EXTRACTION OF KRYPTON AND
XENON IN THE CHEMICAL INDUSTRY

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The sole raw materials source available to us for the
extraction of the inert gases krypton and xenon /Kr, resp.X/
is the surrounding atmosphere from which, anyhow, the gases
oxygen /O_2/ and nitrogen /N_2/ required for the purposes of
oxidation and synthesis are extracted.

In the field of chemical big industry the extraction of
krypton and xenon from the air or from oxygen was shown to be
inexpedient in many cases.

Starting from the instance of modern ammonia synthesis
based on synthetic gas production by oil cracking the different
possibilities of krypton and xenon extraction by low-tempera-
ture distillation are investigated.

The theoretical and actual power requirements as well as
the expenditure of capital invested are evaluated by analogy
to similar plants existing.

The optimum layout of two-stage distilling installations
for the separation of highly concentrated binary mixtures by
low-temperature distillation are commented.

The results obtained by the use of the electronic digital
computer ZRA 1 for the methane /CH_4/ krypton /Kr/ system are
given. The results of experiments for the extraxtion of kryp-
ton and xenon from the residual gases of various types of syn-
theses are reviewed.

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THERMODYNAMICS OF TRANSPORT PROCESSES ON THE PHASE BOUNDARY

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The methods of the thermodynamics of irreversible processes are applied to transport processes on the phase boundary. Integral equations for the basic conservation laws as well as Bernoulli's equation and the first law of thermodynamics are derived for heterogenous systems. The well known differential equations for continuous phases and new phase invariants for transport processes on the phase boundary are then obtained from the integral relations. The second law of thermodynamics for the phase boundary yields expressions for the irreversible increase of entropy, from which follow inequalities for the various transport processes. Linear relations between the driving forces and resultant fluxes are obtained from these inequalities, which can be written in various forms, with corresponding variations in the driving forces and fluxes of which the most interesting are those for simultaneous heat and mass transfer.

The treatment is extended for turbulent flow to consideration of rates of transfer in both fluid phases adjacent to the boundary and conditions are found for addition of resistances and for neglect of thermodiffusion type terms in the rate equations.

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CATALYTIC REMOVAL OF HYDROGEN AND OXYGEN FROM GASEOUS MIXTURES

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Research Center Prague, Czechoslovakia

Recent catalytic processes have been studied as modern and effective means for the removal of undesired components from gaseous mixtures. Special attention has been paid to the recombination of the explosive hydrogen - oxygen mixture in carbon dioxide under the working conditions of a heavy water moderated nuclear power reactor. Further, the study was extended to oxygen removal from nitrogen and elektrolytic hydrogen.

Several platinum metal catalysts of foreign as well as of our own types were tested in a laboratory apparatus of adiabatic type. Comparing the experimental results with theoretic calculations of Boreskov and those of Hougen and Watson, the used catalyst samples were found to be considerably less effective than expected.

The laboratory scale experiments concerning catalytic recombination of the above mentioned explosive mixture were completed by several long-termed experiments in a special testing pressure apparatus with gas circulation, permitting the performance of tests under pressure of 60 - 70 atm using velocities between 20 - 200.000 hr^{-1}. The given survey covers informations on the measurement of oxygen concentration in gaseous mixtures.

Finally, the possible applications of catalytic oxygen removal in the production of protective and controlled atmospheres for metallurgical and chemical purposes are discussed.

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Research investigations on the properties of Turbogrid
trays were carried out on an experimental distillation column
of diameter 1 m and on a hydraulic model of cross section
0,105 m^2.

Nine sets of Turbogrid trays differing in free area, width
of slots and tray spacing are measured on the distillation
column, which operated at atmospheric pressure on a mixture of
methanol and water at total reflux. Four or five trays were em-
ployed. Data were obtained concerning the plate efficiency, pres-
sure drop, and foam height on the tray. The efficiencies were
recalculated to mass transfer coefficients and modifications of
the equations for predicting mass transfer coefficients were pro-
posed. An analysis was made of known relations for determining
the limits of the working range of the trays in view of our ex-
perimental data. Turbogrid trays of differing geometries were
studied hydraulically in the model working with the water - air
system.

A DEVELOPMENT LAW OF CHEMICAL TECHNOLOGY AND ITS IMPORTANCE
FOR AUTOMATION

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Studies on the price trend of nine basic chemical pro-
ducts (H_2SO_4, Na_2CO_3, Cl_2, CaO, $NaCl$, HCl, NH_3, H_3PO_4, and
HNO_3) have shown that this trend can be expressed by the ex-
ponential equation:

$$y(\tau) = a + be^{c\tau}$$

where y (τ) is the average price as function of the time τ
(year). $a = y$ $(\tau)_\infty$ is the assymptotic price limit, and τ the
time/year/. $\underline{b}$ is a positive and $\underline{c}$ a negative constant, each
being characteristic of the individual products.

From the slopes of the corresponding curves representing
the averages it can be seen that every single chemical techno-
logical process shows, in its initial period, a rapid drop in
manuftacturing costs, which becomes in the course of time al-
ways slower. Thus after a certain time a further appreciable
production cost lowering could only be achieved by introduc-
ing another process having radically new features.

The automation in the chemical industry can only cause
further drop in prices proportionally to the ratio of the
wages to the overall costs and by the restriction of break-
downs. In a given technology, however, this drop becomes gra-
dually smaller.

FILM EVAPORATION IN THE REGION OF LOW PRESSURES

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Establishment C. Canzler
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Distillation with minimum losses of thermally instable
substances can be carried out with low boiling temperatures
and with short-time maintenance at the boil. The boiling tem-
perature is a function of operating pressure; certain substan-
ces, especially organic compounds of high molecular weight
should be distilled in the region of very low pressures,
$1 - 10^{-3}$ torr, for avoiding a destruction of the product.

The maintenance of the product in the state of boiling
should be as short as possible; therefore the substance passes
the heated area in the form of a liquid film. In this manner,
very intensive evaporation results, and an increase of boil-
ing point due to hydrostatic pressure of the column of the
liquid can be avoided. Evaporators of this kind were deve-
loped in various designs. With devices which should operate
under very low pressures and especially for the design and
arrangement of some of their parts, a series of critical view-
points should be taken into consideration.

Fundamental data on the problems connected with film
evaporation in the region of extremely low pressures are
given. The paper further covers a description of the design
of special film evaporators, above all of the "Rotafilm"
brand according to A. F. Smith.

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APPARENT THERMAL CONDUCTIVITY OF GRANULAR LOOSE MATERIAL

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A method for the measurement of apparent thermal con-
ductivity of beds of bulk material has been described for
the case that the free space between the particles is filled
by motionless gas, event. under the presumption that the gas
passes between the particles rectangulary to the direction
of heat flow.

With the aid of this method the dependence of numerical
values of apparent thermal conductivity of granular solids
upon fundamental parametres has been investigated. These fun-
damental parametres were: thermal conductivity of the solid
phase, the character of particles deposit, mean temperature
of the beds, and the velocity of gas flow through the free
space between the particles.

Results of experiments were interpreted in the form of
plots and empirical equations.

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INVESTIGATION OF SPRAYING EQUIPMENT FOR HORIZONTAL AND
VERTICAL TUBES

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The influence of the following factors upon the limit
value of the amount of spray water has been investigated for
horizontal and vertical tubes (wetted from outside or from
the inner side): design of spraying equipment, kind, diame-
ter and mutual distance of individual tubes, and temperature
of wetting water. Data are given on the amount of wetting liquid
lost due to springling off. The paper covers also fundamen-
tal information on the calculation of mass flow for various
designs of spraying equipment.

HEAT TRANSFER INTO FLOWING SUSPENSION OF COARSE-GRAINED
AND FIBRIFORM SOLID SUBSTANCES IN VERTICAL TUBE

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Heat transfer from heated tube wall into the flowing
suspension of solid substances in a liquid has been inves-
tigated. The experiments cover heat transfer into suspens-
ions of coarse-grained material with 0,1 - 1,5 mm particle
diameter and into suspensions of fibres. As parameters were
varied: flow rate, concentration of particles and particle
size with suspensions of coarse-grained substances.

Measurements were carried out in a pilot scale experi-
mental equipment / a copper tube of 1500 mm length and
25/30 mm diameter /. Twelve thermo-couples imbedded in the
wall of the tube make possible the measurement of wall tem-
perature as well as exact determination of heat transfer
coefficients.

On the basis of obtained experimental results, coeffi-
cients of heat transfer between the pure liquid and suspen-
sions /non-newtonian liquids/ may be compared with various
particle sizes and different concentrations in dependence
upon flow as well as weight rate of streaming, Reynolds'
number, etc. Results of all measurements were expressed in
dimensionless arguments.

ESTIMATION OF LOCAL HEAT TRANSFER COEFFICIENTS IN MODELS

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An experimental method was proposed for the determination of local heat transfer coefficients in models.

Into the reactor a sound with thermistor heated preliminarily to 150°C has been introduced. Then, the rate of spontaneous cooling of the sound was measured in narrow temperature ranges $/t_p - t_1/$. The heat transfer coefficient between the surface of the sound and the air flowing through the reactor was calculated, taking into consideration losses of heat.

Experimentally determined heat transfer data were compared with values computed from the analogy to mass transfer, whereby an agreement of $\pm 15,8$ % resulted. Further comparison was carried out with data according to Mc Adams' equation:

$$Nu = 0,0 5 \; Re^{0,8} \; Pr^{0,33}$$

In this case, an agreement of $\pm 9,8$ % was observed.

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HEAT EXCHANGE BETWEEN A FOAM LAYER AND THE WALL OF THE
APPARATUS

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Comparative measurements have been carried out of the
heat transfer coefficient between heated wall and cooling
medium, flowing through a foam column. Measurements were made
in the same range of Reynolds numbers with air and water
flows, respectively, and with foam formation in the column
from both above-mentioned components.

With air and water flows the magnitude of heat transfer
coefficient depends noticeably upon their flow rate in the
column.

On the contrary, if the heat exchange between a foam
stratum and the wall of the column was measured, no changes
in the value of heat transfer coefficient were observed in
dependence upon the intensity of air flow in the investigated
range of Reynolds numbers. However, the height of the zone of
foam which is dependent on the intensity of water streaming
in into the interior of the column, has a slight influence on
the values of these coefficients.

MEASUREMENT OF GAS AMOUNT ON THE BASIS OF TAMPERATURE
DIFFERENCES

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The possibility of gas amount measurement on the base of
the temperature differences with adiabatic expansion in a Ventu-
ri tube has been investigated theoretically as well as by means
of experiments. Two thermo-couples connected to an electrical
measuring instrument /galvanometer, voltmeter/ by means of two
conductors served for measurement of the temperature difference.

Due to its simplicity, a similar measuring circuit may be
very useful for the measurement of gas amounts, especially in
high-pressure technics where up to the present differential gau-
ges of very special design are used. With the proposed method,
only two thin electical conductors come out from the measuring
tool.

Good agreement /± 5 %/ exists between results of measure-
ments and a theoretical equation.

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TRANSPORT OF SOLID PHASE IN MULTISTAGE FLUIDIZED BED EQUIPMENT

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Chief prerequisites for successful course of chemical processes in fluidized bed equipment are: the existence of a temperature gradient along the reactor, maintenance of countercurrent action, residence of solid particles in the equipment for long time intervals, and differences between individual time intervals as small as possible.

Often, these requirements can be met only in such manner that the process is carried out in a multistage equipment, whereby solid particles are flowing continuously from tray to tray; a constant height of the bed which has been determined beforehand is adjusted in every individual stage.

Results of experiments have shown which geometric and flow /dynamic/ conditions are critical for trouble-free operation in the plant. A testing apparatus of maximum 5 stages was put together from glass-cylinders of inner diameter 200mm.

Equations and graphic representations show the dependence of transport possibilities of the solid phase /in up- or downward directions/ upon flow conditions and geometric dimensions, being important fundamentals for the design of multistage equipment.

INVESTIGATION OF HYDRODYNAMIC INSTABILITY OF FLUID PHASE
BOUNDARIES WITH MASS AND HEAT TRANSFER

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By optical following of refractive index changes (the
so called "Schlierenmethode") evidence was provided that
hydrodynamic instability of liquid phase boundary region can
be the reason for complex free convection through the boun-
dary area in mass and heat transfer. Changes of experimental
conditions as well as changes of mass transfer conditions re-
sult in different character of the instability of the bounda-
ry region.

Mass transfer experiments in a capillary slot correspond
to a two dimensional model according to Sterling and Scriven,
making possible a verification of proposed theory. This method
gives also the possibility of unambiguous distinction between
free convection across the boundary area and free convection
due to difference of density. Data on the dependence upon the
direction of mass transfer of hydrodynamic instability can be
derived which has been confirmed by quantitative kinetic mea-
surements.

Under conditions of vortex forced convection a certain
slowing down of the whole process was observed with hydrodyna-
mic stability.

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WETTING BEHAVIOUR OF PACKING WITH COUNTERCURRENT
EXCHANGE PROCESSES

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Starting from partition problems in the preparation of
stable isotopes, the phenomena on the boundary between solid
and liquid systems /packing - reflux/ have been investigated
by measurement of contact angles, by following the rate of li-
quid spreading on the solid surface, and finally by shooting
photographic films of known deposition rate. Measurements were
made especially on the systems water/ steel V2A and water/po-
lymers. Most interest has been focused to the influence of the
mean dimension of thickness R , resp. of the swelling capaci-
ty of the polymer with wetting, i.e. also on the efficiency
of distillative production with the aid of packings. Further,
the chemical character of the surface of column packings was
changed on purpose; resulting changes of wetting ability have
been followed.

On the basis of boundary behaviour investigations a series
of novel knowledge fundamentals was obtained which are very
important not only for the development of packings but also for
the design of all sorts of "wetting colums" for countercurrent
exchange processes.

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CONTRIBUTION TO FURTHER DEVELOPMENT OF BUBBLE CAP PLATES

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A critical analysis of today's methods for the dimens-
ioning of bubble cap trays has shown the probable trend of
prospective development.

Observed on nearer view, deciding advances can be await-
ed on the basis of model experiments only, using simultane-
ously criteria of similarity. However, the base of any simi-
larity correlations should be equal partition effect and sta-
tic pressure loss, and not the hitherto exclusively consider-
ed geometry of the tray.

Useful grouping of similarity correlations of bubble cap
plates and their application to the entire column needs, how-
ever, still very much research work as well as more extensive
theoretical considerations.

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PREPARATION OF TRIM ETHYLAMINE BY MEANS OF EXTRACTIVE
DISTILLATION

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Trimethylamine which has a high boiling point may be ob-
tained in high purity from a mixture of monomethylamine and
dimethylamine as the head product of a fractionating column
in extractive distillation with water. For a calculatory so-
lution of the column, preliminary measurement of liquid-vapour
equilibria of individual binary systems is necessary. Referen-
ces can be found in literature for certain pairs of substances.
T-x and P-x fundamentals were measured for the remaining binary
systems. The computation of activity coefficients for the bina-
ry system was carried out according to Tao's method. For the
evaluation of activity coefficients of morecomponent systems,
the Redlich-Kister equation broadened by Böhm and Gelbin was
used. The column has been computed with the aid of a digital
calculator according to a common programme for the treatment of
non-ideal distillation. The result expressed the number of
theoretical plates in dependence upon the amount of added water.

INVESTIGATION OF MASS TRANSFER ON A BUBBLE CAP PLATE

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Visual observation is still very often the only way
for the evaluation of suitable operating parameters of a
bubble cap tray. However, this method does no more corres-
pond to today's technical level, being dependent upon sub-
jective influences.

Therefore, the chief requirements on a new inspection
method are besides simple manipulation and good reproducibi-
lity, especially continuous operating and independence on sub-
jective factors. Measurements are carried out in the liquid
phase; in this manner, the course of mass transfer can be
followed step by step.

All of the other measuring methods which come into
question such as the measurement of humidity, titrimetric
estimation with discontinuous sampling, and conductivity mea-
surement, have various drawbacks. For measurement of mass
transfer, the amended known method of the measurement of elec-
trochemical potential was therefore successfully applied.

Evidence was provided of the utility and technical sound-
ness of this measuring method on a plate of 600 mm diameter
for the systems CO_2 - air - water and NH_3 - air - water. Re-
sults of measurements show very good reproducibility as well
as adequate accuracy for technical purposes.

CALCULATION OF EQUIPMENT FOR NITRIC ACID PRODUCTION

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Hitherto known interrelations for the determination of
equilibrium and velocity constants needed for computation of
dimensions with nitric acid production equipment do not in all
cases satisfy today's requirements. Therefore, a new equation
for the computation of equilibrium constants of nitrogen di-
oxide absorption has been derived. Constants which were cal-
culated in this manner are in very good agreement with values
measured by various authors.

Known methods for the calculation of absorption units
for mixed nitrogen oxides are discussed. Evidence is provided
that today plate columns for nitric acid production can be
dimensioned with adequate accuracy. However, no calculating
method for packed columns hitherto proposed satisfies all re-
quirements. Because all reactions which participate in nitric
acid formation occur in such columns simultaneously, it seems
useful to express the concentration changes of participating
gases along the height of column packing by means of a system
of simultaneous differential equations which can be solved
numerically.

The final, most exact dimensioning of packed as well as
of plate columns is always carried out, as a matter of prin-
ciple, in quite another manner than with the preliminary,
first calculation.

NEW TYPES OF PLATES FOR CO_2-SCRUBBING BY MEANS OF WATER AND INTENSIFICATION OF THE SCRUBBING PROCESS

K. Vydra

Chemické závody československo-sovětského přátelství

Záluží u Mostu, Czechoslovakia

The paper deals with the foam method for scrubbing of gases and vapours in scrubbers equipped with vortex plates. The application of these trays is suitable in such industrial processes where the flow ratio of effective volumes of liquid to gas varies in the $1 \pm 0,8$ range /CO_2 absorption, etc./.

In greater detail are dealt with:

1/ a concise review of hitherto mostly used trays for these conditions, their advantages and shortcomings /packings, bubble-cap and Kittel plates/

2/ a description of the design and action of vortex trays, comparison of their advantages and disadvantages with plates of other types

3/ a summary of plant results — data on capacity and efficiency obtained in the course of practical tests with plant units of $2,1$ and $2,8$ m diameters

DRYING OF LIQUIDS WITH LIMITED WATER MISCIBILLY BY
MEANS OF AZEOTROPIC DISTILLATION

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Research Institute for Synthetic Rubber
Gottwaldov,Czechoslovakia

The possibility of the use of azeotropic rectification
for the drying of same hydrocarbons has been investigated.
Physical parameters were established which are deciding for
the partition ratio between liquid and gaseous phases, res-
pectively, being especially the determining factor for the
final content of water in the dried raw material. Measured
partition efficiency of a laboratory bubble cap plate, of a
pilot scale sieve tray, and of the HETP-value of Raschig
rings demonstrate the wide range of application possibili-
ties of this method.

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HYDRODYNAMICS OF STIRRED EXTRACTION COLUMNS

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Research Institute Královopolská strojírna, Brno

Research Centre Prague, Czechoslovakia

An analysis of hydrodynamic phenomena in extraction columns with mechanical agitation is presented. Five fundamental problems were solved:

a/ splashing of liquid drops dispersed by the action of a disc agitator

b/ velocity of vertical movement of liquid drops through agitated columns

c/ coalescence of drops in stirred extraction columns

d/ power consumption of disc agitators in columns

e/ design equation for agitated extraction columns and calculation of flooding conditions.

Main prerequisites for the solution of the above mentioned problems together with a quantitative mathematic treatment and a comparison with experimental data, confirming the validity of theoretical conclusions are given. The consistence of fundamental conceptions and experimental data is emphasized.

INFLUENCE UPON MASS TRANSFER OF IMPACT FLOW IN CONSIDERATION OF
EVENTUAL DRYING APPLICATIONS

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State Research Institute of Heat Engineering
Prague, Czechoslovakia

The author investigated experimentally, by means of naphtha-
lene sublimation from a divided testing plate, the influence upon
mass transfer of an air stream leaving the nozzle rectangulary to
the area of evaporation. For flow rates w = 10 - 40 m/s which
were measured in the mouth of the nozzle /widths b = 5 - 40 mm/
local values of mass transfer coefficients were established for
the region of nozzle-plate distances s = 1 - 80 b. Results have
been compared with the dependence of mean values of mass transfer
coefficient. Then, by more exact analysis, the optimum distance
between the nozzle and area of evaporation was established.

STABILIZATION OF PEARL POLYCONDENSATION BY MEANS OF
INTERPHASE REACTION

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and Research Institute of Synthetic Resins and Lacquers
Pardubice, Czechoslovakia

In the production of strongly acid cation-exchange resins
with the aid of suspension polycondensation in dispersed medium
/chlorinated hydrocarbons/, the possibility arises of suspension
stabilization by means of interphase reaction of higher fatty
alcohols with the surface of the dispersed, strongly acid react-
ion mixture.

The authors investigated the region where this system may
be applied as well as the influence of some factors upon the
location of the boundary region between the sites of pearl and
bulk polycondensation, respectively. The influence of the com-
position of dispersed medium, and of ist viscosity was esta-
blished more exactly than hitherto known. Graphic representation
of interrelations has been carried out by establishment of the
boundary region between pearl and bulk polycondensations by
evaluation of their positive and negative results.

41

ON INHOMOGENEITIES IN THE FLUIDIZED BED

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Research Institute of Organic Syntheses

Pardubice, Czechoslovakia

An investigation of mutual action of forces between the particles and the liquid in a fluidized bed has shown that inhomogeneous distribution of concentration may arise in the whole stratum.

Bubbles are formed in the fluidized bed due to considerable differences in specific masses of particles and gas, respectively. Their dimensions depend especially on physical properties of particles and fluids. Their size can increase considerably, and finally the whole cross section of narrow tubes can be occupied by bubbles /the so called "piston formation"/.

The determination of such diameter of the apparatus whereby the formation of pistons is just starting makes possible the characterization of the whole process of bubble formation for the system particle fluid given.

The character of the flow of fluidizing medium through the bed can be described in terms of two simple criteria

$$\frac{d_{tb}}{d_s} \qquad \text{and} \qquad \frac{d_{tb}}{d_t}$$

The first formula expresses the correlation between the sizes of the bubbles and the particle size d_s , the second criterion interprets the influence of aparatus diameter d_t . The first simplex can be transferred into a more advantageous form which is, however, a function dependent upon the flow of the medium through the fluidized bed.

VIBRATING-PLATE COLUMN FOR LIQUID-LIQUID EXTRACTION

J. Procházka, J. Landau, P. Nekovář and F. Souhrada
Institute for Chemical Process Fundamentals, Czechoslovak
Academy of Science, and Department of Chemical Engineering,
Institut of Chemical Technology,
Prague, Czechoslovakia

A new type of extraction column with vibrating plates is
described. The dispersed phase forms a continuous layer on or
below each plate, the openings of which are fitted with short
straight pieces of tube. The vibrating action of the plates
forces liquid through the openings and as a result, a suitable
dispersion is being formed. The continuous phase flows across
the plates and through the free cross section of the column.

Results of hydrodynamic experiments with the system tolu-
ene-water are given, showing the influence of amplitude and fre-
quency of vibrations and distance between plates on the through-
put of dispersed phase, for several types of plates. For the same
arrangements there are also given results of extraction tests
with the system toluene-acetone-water.

The results of these experiments show that for this type
of the column high efficiencies and relatively high throughputs
of both phases can be achieved. The design and action of the
column can be adapted to suit diverse conditions of liquid-liquid
extraction.

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PARTITION OF HYDROCARBON GASES USING LIQUID COOLANT

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A process for the partition of hydrocarbon gases using di-
rect contact with a liquid refrigerant /aqueous calcium chloride
solution or solutions of other salts/ has been elaborated in the
Research Institute of Synthetic Alcohols and Organic Substances
together with IIG AN USSR /Soviet Academy of Sciences, Institute
for the Utilization of Gases/. A patent application N° 132·246
of July 18th 1960 was filed.

The method proposed for partition of hydrocarbons needs
considerably less heat exchange area; this means noticeably
decreased investment costs for plant equipment.

Simultaneously, the consumption of energy needed for the
process decreases due to the facts that 1° the temperature dif-
ference between terminal gases and liquid coolant does not ex-
ceed $1 - 2 \,^oC$, and 2° the products are condensed and rectified
in non-adiabatic manner at the same time. '

Now, possibilities of ice and hydrates formation in the
equipment are eliminated and the drying of individual gas fract-
ions after partition is investigated.

The paper involves results of investigation on hydrodyna-
mics, heat and mass transfer on the plates of a rectifying co-
lumn in the presence of a second, inert liquid phase /the re-
frigerant/. A condensation-evaporation column for the partition
of waste gases from petroleum well drilling has been calculated
with the aid of an electronic numerical counting device.

PARTITION OF LIQUID AND GASEOUS HOMOGENEOUS MIXTURES ON POLYMERIC MEMBRANES

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Institute of Chemical Technology
Moscow, USSR

An investigation of partition ability of some semi-permeable polymeric membranes has been carried out. These membranes were pervious to some components of the mixture selectively in certain direction only.

It was found that a whole series of polymeric membranes can be used for the partition of gaseous and liquid homogeneous mixtures. Evidence was provided that even azeotropic mixtures can be separated into components. In comparison with rectification, the application of polymeric membranes for partition of liquid mixtures may result in considerable savings /40 to 50 %/. The mechanism of the process and also the dependence of partition rate /mass transfer/ upon the following parametres were investigated: on the thickness and structure of the membrane, the flow rate, pressure, temperature, and concentrations. Corresponding correlations were obtained for the computation of equipment for mass transfer, whereby a polymeric membrane serves as a partition element. Evidence was provided that the novel technique for partition of liquid and gaseous homogeneous mixtures on a semi-permeable polymeric membrane is an interesting one.

ON THE COMPUTATION OF ABSORPTION AND RECTIFYING PLATE COLUMNS

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Moscow, USSR

A simple uniform correlation has been obtained for the
calculation of heat and mass transfer coefficients on contact
trays. It was shown that mass transfer coefficients are defin-
ed be means of identical equations for the liquid and gaseous
phase, respectively.

Evidence was provided for the analogy between processes
of heat, mass and momentum transfer on contact plates.

The authors deal further with the possibility of the com-
putation of the efficiency of contact plates in dependence
upon the magnitude of hydrodynamic resistance of a gas-liquid
mixture on the plate.

CALCULATIONS OF OPTIMUM OPERATING CONDITIONS AND CONNECTION
SCHEMES FOR CHEMICAL REACTORS

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Moscow, USSR

The selection and calculation of optimum connection
schemes and operating conditions for chemical reactors be-
long to the most important chemical engineering problems
since the development of modern calculation technics.
In the opinion of the authors, the theory of dynamic
programming represents the most promising trend for the
solution of this task.
Solution methods were elaborated for systems of chemical
reactions with unlimited complexity carried out in a series
of adiabatic reactors, in reactors with perfect stirring, in
closely packed polytropic reactors, and finally in a series
of two-phase reactors. The last named case is a model for
fluidized bed processes. Results which the authors have ob-
tained due to the introduction of some mathematical opera-
tions broaden considerably the scope of problems for which
now an effective "almost analytical" solution is at disposal.

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PERSPECTIVES OF INDUSTRIAL APPLICATION OF MASS TRANSFER
IN FILM UNITS

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Moscow, USSR

Equipment for mass transfer in a thin liquid layer /film/
is distinquished by small hydrodynamic resistance, the possi-
bility of using high loadings, and by small holdup of the liquid
in the volume unit of operating space. Due to these properties,
possibilities exist of broader use of this technique for the
partition of thermally instable substances in industrial
plants too.

In recent years, various designs of film columns and
partition equipment have been developed which make possible
to apply this technique for small /about 1 $m^3/_m2_{.h}$/ as well
as great /up to 1000 $m^3/_m2_{.h}$ / loadings of the liquid. High
partition efficiencies were attained, as the rule 0,5 - 1 m,
expressed in terms of the height equivalent of the mass trans-
fer unit.

Today is taken for granted the application of industrial
film rectifying and absorption columns of up to 2 m diameter
and a height of up to 30 m.

ON THE INFLUENCE OF AGITATION ON VARIOUS PROCESSES OF CHEMICAL TECHNOLOGY

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Technical University
Leningrad, USSR

Mechanically stirred units are very often used in chemical industry. However, this equipment does not meet sometimes all technologic requirements needed.

In many cases useful operating conditions, e.g. the correct number of RPM of the stirring gear can be found by means of calculation.

Model experiments, if any, should be arranged in such manner that required data are obtained in a way as short as possible.

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ON IMPORTANT HYDRODYNAMIC PARAMETERS IN GAS PHASE MASS
TRANSFER WITH AERATION

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and Technical University for Chemical Machinery
Moscow, USSR

Gas phase mass transfer has been investigated for the
special case of ammonia absorption by water from an ammonia
-air mixture.

Results of more than 600 experiments cover in broad ran-
ges the influence of variations in geometric arrangement of
the plates as well as of changes in liquid and gas loadings.

For sieve plates, the dependence of mass transfer
coefficient upon gas velocity in the column W_k and the height
of static holdup of the liquid on the tray h_{st} corresponds
to equation

$$K_g a = A W_k^n \; h_{st}^{\;m}$$

Agreement between this expression and experimental data $= \pm 15\%$.

The form of criterial equations which describe the gas
phase mass transfer with rectification and absorption pro-
cesses in plate equipment has been discussed.

MODELLING OF RECTIFICATION UNITS

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Kyjev, USSR

Investigations in the field of rectifying can be carried out successfully on small scale experimental equipment.

Dimensions of such equipment result from rules derived from similarity and modelling theories.

Modelling techniques of plate rectification columns have been proposed for two possibilities:

1. investigation of hydrodynamics and mass transfer,
2. for technologic purposes.

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DRYING OF FINELY DISPERSED DYESTUFFS

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A technologic scheme has been elaborated for the drying of finely dispersed azoic dyestuffs and pigments. It may be used for other substances, too, which are either sensible to overheating or give explosive mixtures with air. A spray-drying equipment operating in a closed recycle of inert gas serves as plant equipment.

The technologic method proposed makes possible perfect automation of the drying operation.

A special unit has been designed for the production of inert gas; testing runs provided evidence for its utility in industrial application. Minimum oxygen content in air is attained by combustion of lighting gas.

Hitherto carried out investigations of the spraying process made already possible the calculation of main dimensions of the spray-drying equipment as well as the determination of the design of its parts.

The paper deals further with practical experience in the application of this technique and the design of chief parts of a special spray-drying equipment for the drying of finely dispersed dyestuffs.

HERMETIC REACTORS FOR CARRYING OUT LIQUID-PHASE PROCESSES

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Research Institute of the Petroleum Chemistry
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Mighty stirring of reactants is absolutely necessary
for the intensification of liquid-phase processes. Agitation
amends diffusion conditions, maintains isothermal prerequisi-
tes of the process, and contributes to better heat transfer
through the wall of the reactor.

If high Reynolds' criteria which characterize the stir-
ring should result, great velocity of reactants moving along
a distinct circulation path is necessary. Reactors with great
ratio height : diameter, equipped with a circulation tube
immersed up to the bottom of the vessel are therefore re-
commended. A propeller type agitator is located in the upper
part of the circulation tube, being driven electromagneti-
cally /n = 1400 RPM/.

Absolutely hermetic sealing of the equipment amends o-
perating conditions and decreases the fire risk in plants.
The application of electromagnetic drive makes possible the
design of reactors, autoclaves, pumps, blowers and other ma-
chines which are operating practically at any pressure and
under absolutely hermetic conditions.

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INVESTIGATION ON GRAVITY FLOW RATE OF GRANULAR MATERIAL
FROM CONTAINERS

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Technical University

Szczecin, Poland

The effect of bed height, particles diameter, outlet ori-
fice diameter and inclination angle of conic bottom on the gra-
vity flow rate of sand was investigated. At the issue of the
work and of about 1500 measurements made, the following dimen-
sionless empirical equation was obtained:

$$\frac{1}{G} = \frac{\frac{D^2}{4} \gamma \sqrt{2gD}}{W} = /78,4 \; \sin \; \frac{90-\beta}{2} - 2,9/\cdot / \frac{d}{D} + 0,011/ + 1,6$$

where d - average size of particles
 D - outlet orifice diameter
 W - mass rate of flow
 γ - bulk density of material, and
 β - inclination angle of walls of the conic bottom.

The influence of the bed height on rate of flow has not
been ascertained. The rate of flow is growing with increasing
value of inclination angle β , but only after such angle supe-
rating of a certain important limit value /for the sand it be-
ing 60°/. For $\beta = 0 \div 60°$ it is necessary to interpolate into
the equation the value $\beta = 60°$. It is more practical to use
equations of a simplified form: $1/G = A + B/X$; A and B are
constants for a given β angle. With $X = D/d$ 6 the flow tends
to halt, and with D/d $100 \div 200$ the rate of flow is practi-
cally independent from the D/d ratio, and the dimensionless
modulus G equals $0,55 \div 0,62$, like in the case of water out-
flowing from container.

·FLOW AND PARTITION CONDITIONS IN TUBULAR CENTRIFUGES

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Budapest, Hungary

Cetrifugal separators as a means for "cold" separation
of mixtures are well known for tens of years in chemical enginee-
ring whereby their importance is steadily growing. However,
they have been characterized very often by such empirical and
comparative parametres only which practically did not take
into consideration the impact onto the sedimenting particle
of liquid flow.

The aim of this investigation was to give theoretical
as well as experimental fundamentals of the laws of turbulent
flow in a tubular centrifuge whereby the process of sedimen-
tation should be studied with special care.

Two fundamental equations have been derived:
a) for the motion curve of the sedimenting particle and
b) a very precise one for limit particle size.

Practical utility of equation a) was experimentally ve-
rified on a special centrifuge by a great series of measure-
ments.

From empirical experience, similar correlations have been
derived also for laminar flow of the liquid which are discuss-
ed in the second part of the paper.

ON THE ANALOGY OF HYDRODYNAMIC CONDITIONS AND MASS TRANSFER
ON SIEVE PLATES IN DIFFUSION UNITS

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Budapest, Hungary

It was shown that plate efficiency can be expressed in
terms of Stanton's index which characterizes momentum, heat
and mass transfer, and interpretes the analogy of these pro-
cesses. A correlation between the so called $\underline{j}$ factor and
Reynolds' criterion, i.e.:

$$j = 0,33 \cdot Re_g^{-0,2}$$

has been derived from experimental data.

This factor $\underline{j}$ is in close connection with the efficiency
of sieve trays of rectifying columns; analogous interrelat-
ions exist also in similar cases.

This equation expresses the analogy between

a/ the dependence of partition ability upon Reynolds'
criterion for plate, packed, and film columns, and

b/ hydrodynamics and mass transfer, respectively.

Analogy b/ makes possible the application of hydrodyna-
mic data on plates in the calculation of their efficiency.

MASS AND HEAT TRANSFER INTENSIFICATION DUE TO ARTIFICIAL ROUGHNESS

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Iasi, Roumania

The paper deals with phenomena in a wavy film of wetting liquid which result in an intensification of mass and heat transfer.

Experiments have been carried out for the water-air system in such manner that water in the role of wetting liquid flew downwards either as a film in tubes or over bulk packing. In both cases smooth surfaces as well as surfaces equipped with artificial roughness were exmined.

Laws on the influence of roughness upon heat and mass exchange process have been derived for film flow in a wetted wall tube as well as for free flow through packings.

Chief factors which influence exchange processes are:

1) Increase of free surface of the liquid in the presence of roughness due to increased thickness of the film.
2) Increase of free surface of the liquid due to changes of the shape of waves.
3) Increase of turbulence in the presence of roughness.

Mass transfer increased by about up to 80 % whereby the increase of energy consumption did not exceed 15 %.

Obtained results can be applied to industrial practice without difficulties.

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SOME PROBLEMS OF THE PRESENT STATE OF RECTIFICATION THEORY
AND PRACTICE

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Moscow, USSR

The author discusses problems of phase equilibrium in
the liquid-vapour system, and proposes methods for the calculation
of activity coefficients. A review of rectifying kinetics is
presented and interrelations between local efficiencies and plate
efficiency are described.

A novel term, the so called " diffusion efficiency" has
been proposed by the author who analyzed theoretically thermal
distillation as well as mutual interaction of phases.

Generalized equations for mass transfer and their use
for the computation of various types of diffusion equipment are
discusses in greater detail.

Rectifying columns of several types were compared on
the basis of their capacity related to volume unit of the equipment
and consumption of energy on one partition stage. Possibilities of
increasing the capacity of rectifying columns are also dealt with.

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A CONTRIBUTION TO THE THEORY OF DRYING OF POLYDISPERSE
SYSTEMS OF SOLID PARTICLES IN A FLUID FLOW

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Prague, Czechoslovakia

A system of differential equations was derived enabling
to describe the process of drying of monodisperse materials in
a flow-type drying plant; this system was generalized for poly-
disperse materials. The polydisperse system of solid particles
was substituted by n monodisperse systems /fractions/ and the
definite system of differential equations related to the phys-
ical process involved was obtained in matrix form.

The author further gives a numerical solution of the pro-
blem to illustrate the effect of polydispersiveness upon the
physical process.

The second part of the contribution deals with the experi-
mental verification of theoretical results. A brief description
of the experimental apparatus and measuring method are given
and also a comparison of theoretical and measurement results.

TURBOGRID PLATE ABSORBER FOR SCRUBBING SUPPERPHOSPHATE TAIL GAS

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Ústí n.L., Czechoslovakia

A pilot-scale absorber for scrubbing tail gas from super-phosphate manufacture fitted with two Turbogrid-type plates was continuously operated for several days to demonstrate the technical soundness of such equipment. The main design features and experimental data on mass transfer coefficients and pressure drops are presented. Evaluation of this data shows that fluorine-removal efficiencies ranging from 93 to 99,8 % were attained. Highly concentrated fluosilicic acid (up to 30 w.%) was produced. In no case the scrubber was blocked by silica deposition. Conditions guaranteeing trouble-free operation are discussed.

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SOLUTION OF AN EQUATION FOR THE DISTRIBUTION OF TEMPERATURES IN
THE INTERIOR OF A PLATE WITH NONSTATIONARY COOLING-DOWN

A. Matějíček

Research Institute for Synthetic Resins and Lacquers
Pardubice, Czechoslovakia

A common mathematical solution of the time dependence of
temperatures in the interior of a plate during its cooling down
in a medium with constant temperature is presented.

This case has been solved for a plate of limited thickness,
other dimensions were unlimited. A partial, differential equa-
tion of the Laplace type $\dfrac{\partial t\,(x,\tau)}{\partial \tau} = a\,\dfrac{\partial^2 t\,(x,\tau)}{\partial x^2}$
has been solved with the aid of operator calculus for two different
groups of border conditions. Common for both cases are the initial
condition of constant temperature with any point of the plate at
the start $t\,(x,o) = t_o$
and further the ratio of heat transfer coefficient and the coeffi-
cient of thermal conductivity, corresponding to relation $\dfrac{\alpha}{\lambda} \neq \infty$

In the first case, the task has been solved under the condition
that the temperature of the wall is an exponential function of time.

For the second case, besides this condition a further one has
been considered, i.e. that the heat transfer coefficient is a li-
near function of the temperature on the surface of the plate.

An expression for the temperature in any point of the plate
at any time results in both cases. It is represented by a sum of
expressions, where the position of the point tested plays the role
of an argument of a trigonometric function, and the time is ex-
pressed by means of a negative exponent of number e . Individual
coefficients in these series of sums are functions of border con-
ditions which are different for both cases.

MOMENTUM AND HEAT TRANSFER IN TWO-PHASE FLOW UNDER PRESSURE

I. Klumpar
Závody vítězného února
Hradec Králové, Czechoslovakia

Pressure drops and heat transfer coefficients of nitrogen and of a mixture of nitrogen with evaporating water or condensing steam were measured in a pilot-plant equipment consisting of a series of vertical tubular heat exchangers at a pressure of 80 atm, at temperatures of 0 to 300°C, and at flow rates of 100 to 450 kg nitrogen and 20 to 150 kg water per hour.

Evaluating the heat-transfer results the Reynolds analogy and the homogeneous model were applied to the two-phase flow through a non-circular duct. Also the two-phase heat capacity was defined in a new manner including latent heat. The ratio of two-phase to liquid heat transfer coefficient was correlated versus the corresponding ratio of frictional pressure drops resulting in a straight line contrary to Fried's curve.

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NOVEL CONCEPTIONS IN ABSORPTION TECHNICS - A COLUMN WITH PACKING
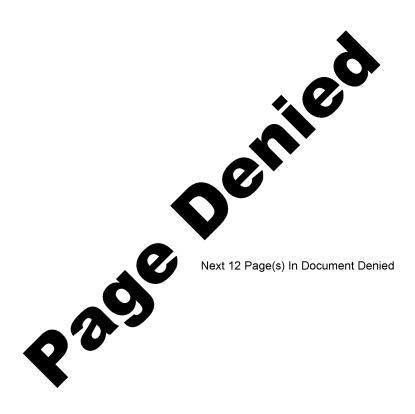OF WIRE SPIRALS

R. Klimeček and J. Bettelheim
Research Institute of Inorganic Chemistry
Ústí n. Labem, Czechoslovakia

The paper deals with the unsuitableness of some types of
basorption equipment for sulphur dioxide from flue gases of thermal
power stations. All types of absorption units hitherto have been
designed for other purposes and were intended for other goals; there-
fore, their application for this purpose is not advisable.

On the contrary, it may be taken fro granted that an
industrial scale solution of this problem should make possible the
development of special units designed especially for the above-
mentioned application.

The authors have designed and checked on a model a novel
absorption equipment of unusually high operating indices. A height
equivalent to the transfer unit of 1 m and hydrodynamic resistance
corresponding to this height equal to 15 mm Hg were observed with
apparent velocity in the equipment equal to 5 m/s, and wetting
intensity less than 3 m^3/m^2.

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CONTINUOUS PHASE MASS TRANSFER IN EXTRACTION PROCESSES

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Bucureşti, Roumania

In part I of the paper, a number of equations for mass transver from a quasi-independent drop are established, which take into account also the influence of capillary active substances.

In part II, the case of a drop-ensemble is examined starting from a physical model, and equations are established for the transfer coefficient in the continuous phase.
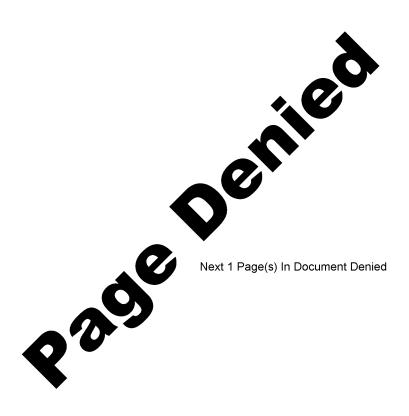
HYDRAULICS OF SIEVE AND TURBOGRID TRAYS

T. Hobler, R. Krupiczka and J. Czajka
Research Centre of Chemical Engineering and Chemical Machinery,
Polish Academy of Science
Gliwice, Poland

Investigations were carried out on sieve and Turbogrid trays in conditions of the flow of water, air and of liquids such as Kogasin, oils, glycerol and its solutions.

A common correlation has been achieved for trays of both types.

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DRYING OF BULK GOODS WITH HIGH OVERHEATING

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Warszawa, Poland

Temperature and humidity distributions have been established, transfer coefficients were measured with simultaneous heat and mass transfer, and the dependence of drying rate upon initial humidity was investigated in the drying process of bulk goods which were filled into a cylinder of 25 cm height and 12 cm diameter of the base. The cylinder, suspended on a scale-beam, was heated by the action of heating steam; the mass was penetrated from the bottom by dry air of laboratory temperature.
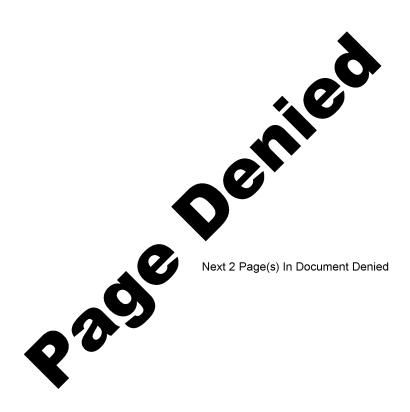
The quantum of passed heat was calculated from the amount of condensate deposited in the chamber of parted heating jacket. Temperatures of steam and cylinder wall were measured by means of thermocouples at various levels; resistance thermometers served for the measurement of internal temperatures of the bed of bulk goods.

The size of average particle of bulk good and the rate of air flow were varied in the course of experiments which were carried out by means of the non-steady state heat transfer method. Changes of temperature and humidity were recorded in both transversal, and longitudinal layers of the substance.

The author aimed also at a mathematical interpretation of the whole process.

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CONTRIBUTIONS TO KNOWLEDGE OF MECHANICAL AGITATION OF LIQUIDS

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A team of collaborators investigated the following processes ocuring in the liquid charge of a mechanical stirrer:

1) the homogenization of completely miscible liquids,

2) suspending of a granular solid phase,

3) dissolution of a granular solid phase.

As introduction to this activity of the team which is still continuing, the problem of power input measurement has been considered from theoretical viewpoints. The stochastic character of liquid movement in the charge of the stirrer was demonstrated in experimental and statistic manner.

The characteristic random flow observed was deciding fro the conception of problems discussed. •

Model imaginations used and results of the investigations were discussed simultaneously. In this way, the methodical importance of model conceptions for such studies is emphasized.

AMMONIA SYNTHESIS IN THE PRESENCE OF OXYGENIC SUBSTANCES

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The synthesis of ammonia from a mixture of nitrogen and hydrogen under high pressure on iron catalyst is slowed down in the presence of oxygenic substances. According to references from literature, a content of 0,05 vol. % O_2 in the synthesis mixture at a pressure of 300 atm. slows down the velocity of ammonia synthesis at a temperature of 400 °C to only about 1 - 2 % of the initial value in the absence of oxygenic substances. However, a temperature of 500 °C results in multifold rate of ammonia synthesis, and at 600 °C practically no slowing down of reaction rate can be observed.

If the catalytic hydrogenation of oxygenic substances which are contained in ammonia synthesis gas is carried out on iron catalyst under high pressure at ammonia synthesis temperatures, maintaining of sufficiently high temperature is necessary in regard of the above-mentioned retarding of oxygenic substances on the ammonia synthesis proper.

Preheating of synthesis gas to high temperature is in close connection with heavy-duty heat exchange system of the reactor. Therefore, several new schemes for the arrangement of ammonia synthesis gas pre-heating were elaborated, using plate reactors for the synthesis of ammonia in the presence of oxygenic substances.

Arrangement of reactors according to various schemes has been compared from the viewpoints of heat exchange system as well as of catalyst efficiency.

RESEARCH AND DESIGN OF DEVICES FOR MULTISTAGE MOLECULAR
DISTILLATION

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The paper deals with development results of two types
of devices for multistage molecular distillation. The first
apparatus is a slep type device of rectangular cross-section
equipped with cells dimensioned 100x60 mm, whereas the second
device has circular cross-section and involves a revolving
rotor, which wipes the film of the liquid on heated walls
of the equipment.

The investigations have been carried out with a blend
of paraffinic oils of the Octoil and Octoil C types.

FLUIDIZED BED DRYING

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The paper is devoted to fundamentals of fluidized bed drying as well as to problems of practical application of this method of drying. The author deals with material transport, individual types of drying equipment, the kinetics and thermodynamics of fluidized bed drying, heat and mass transfer coefficients, etc. In more detail are discussed dynamic problems such as the drying of fine powders, the granulation, attrition and breaking of particles, and electrostatic phenomena in the fluidized bed.

Novel aspects are presented by the author on the drying of solutions with simultaneous evaporation, cristallisation and dehydration, on the so called "shock-fluidization", and on drying in spouted fluidized bed.

Further items of the paper are: measurement and automatic control of the process, drying of substances with chemically bound water, drying of corn, processing of hydrated salts, and drying of different bulk goods.

Finally, this method of drying is discussed from the economic viewpoint.

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PROBLEMS OF ANTICORROSIVE PROTECTION OF EQUIPMENT
FOR REFINERIES

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The methods of anticorrosive protection of equipment for
the crude oil industry stem from the analysis of corrosion
factors. They are based on corrosion tests in laboratory and
service conditions.

An analysis of the conditions for corrosion of steel
tanks for storing crude oil and crude oil products was
carried out and on its basis, in addition to corrosion tests,
the most suitable systems of surface protection were chosen.

The results of laboratory and service corrosion tests
in the conditions of the crude oil distilling process demon-
strate the great aggressivness of processed crude oils. They
permit to propose the optimum material application of
Czechoslovak made metals in the construction of individual
parts of refinery equipment and to create conditions suited
for the application of an expedient method of protection by
means of adaptation of the medium: desalinization of crude
oil, neutralization and inhibitors.

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MULTISPINDLE WORM-TYPE HYPERBOLOID BATCHING PUMP FOR HETEROGENEOUS FLUID SUSPENSIONS

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The topic of the lecture is formed by the description of the original design of a multispindle worm-type pump for continuous batching of heterogeneous suspensions.

The main parts of the hyperboloid worm pump (Czechoslovak patent No.101 592) are formed by two (respectively more) synchronously rotating independently running hyperboloids fitted with threads.

This feature, in comparison with the conventional worm-type pumps, affords considerable advantages, e.g. the particles of the solid phase are not drawn into the wedge spaces of the screw spindles but forced out. This constitutes the characteristic feature of the described pump.

The author gives a description of the mathematical and geometrical solution of the engagement of the rotary screw hyperboloids and deals with the hydraulic conditions of the pump which may find good application, in particular, in the chemical industry.

STEELS WITH TWO-PHASE STRUCTURE TYPE Cr21Ni5Ti

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The two-phase structure steel type Cr21Ni5Ti, being the substitue for steel Cr18Ni9Ti, is a new material for chemical industry. In comparison with classical steels of type Cr18Ni-9Ti the developed material has a higher yield point and a higher rigidity. Apart from saving of nickel in steel-making, it is possible to keep down the nickel amounts by utilizing resisting properties of these steels. Plastic properties of economic steels depend upon the content of austenitic phase in the steel. These properties are lower than in purely austenitic chromium-nickel steels, but higher than in ferritic chromium steels. A higher content of chromium even with a decreased content of nickel gives to these steels - in comparison with the steel known as type Cr18Ni9Ti - a very good corrosion resistance. Developed steels may be welded by means of known electrodes of austenitic type as e. g. Cr18Ni9Nb. After welding, these steels have good resisting properties against the intercrystalline corrosion even in the case where titanum as stabilizing inclusion is absent. The developed steels disadvantage is their small structural stability. They may be recommended for use where temperatures up to 300-350°C are encountered.

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MULTI-MEDIUM HEAT EXCHANGERS USED IN SEPARATING GAS MIXTURES.

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When analyzing the most suitable application of various types of multi-medium heat exchangers, the authors have arrived at the conclusion that tube heat exchangers without partitions can be used only if the physical properties of the fractions flowing through the tubes are the same. In tube exchangers with partitions, the influence of various properties can be reduced by the choice of a suitable fraction rate. Moreover, in coil-type heat exchangers the length of the tubes for the particular fractions can be changed. In concrete cases it is necessary to choose a suitable type of heat exchangers on the basis of economic calculations.

PROBLEMS RELATING TO CORROSION IN CERTAIN HIGH PRESSURE
SYNTHESES USED IN THE NITROGEN INDUSTRY

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The authors deal with the resistance to hydrogen corro-
sion and nitridization which they consider to form the prin-
cipal question in the choice of suitable material for high
pressure syntheses (production of ammonia, etc.). Austenitic
anti-corrosion steels offer great resistance to the complex
corrosion affect of hydrogen, nitrogen and ammonia at high
temperatures and pressures. On the basis of the knowledge of
the mechanism of corrosion, in the conditions of the synthe-
sis of ammonia, efficient low-alloy steels stabilized by
titanum are suggested and followed up.

In the most exposed parts of a reactor, a combined affect
of corrosion and erosion occurs. In these conditions, certain
types of austenitic steel and, in particular, the influence
of the molybdenum content in steel, type Cr18Ni10, were fol-
lowed up. It has been found that an increase of the molybde-
num content within the range of 1,5 to 2,5 per cent causes
the corrosion values to decrease. The presence of a sufficient
quantity of molecular oxygen in the reaction mix reduces cor-
rosive aggresion to such an extent that steel Cr18Ni19 contai-
ning no molybdenum can find application.

COMBUSTION OF FUEL OILS AND ECONOMIC UTILIZATION OF OIL
FIRING IN INDUSTRY AND FOR STEAM BOILERS

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Considerations of economy have led to the conclusion
that coal as a source of heat was replaced in many industries
by fuel oil.

When firing oil, it is necessary to take care that the
oil should be, as far as possible, atomized into fine drop-
lets of equal size. This task is performed by the oil burner
that atomizes the liquid fuel. But not only mere atomization
of the fuel, but also the expedient conveyance of air,
necessary for combustion into the combustion chamber and the
perfect combustion of the fuel oil are of great importance.
It is necessary to know, how these tasks are solved by the
particular types of oil burners.

Moreover, reference is made to the unambiguous relation-
ship between corrosion influences and the melting point of
inorganic compounds from oil ash.

Further problems in firing fuel oils, such as coking up
of burners, pulsating flame, bad combustion and soot forma-
tion are dealt with.

HEAT TRANSFER IN THE CONDENSATION OF SATURATED STEAM
IN CONE-TYPE HEAT EXCHANGERS

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This paper is devoted to the problem of determining
the coefficient of heat transfer in the condensation of
saturated steam on the outer surface of exchangers formed
by a combination of conical and cylindrical areas. The
solution supposes the validity of assumptions analogous to
those used by Nusselt in solving the question of condensation
on a vertical plate. The analytical determination of the
mean value of the heat transfer coefficient by integration
of local values along the surface of the cone can be carried
out in a closed form.

The criterial relationship between Nusselt's number,
the criterion of condensation, and a series of form simple-
xes determining the shape of the respective structural
combination of cylinder and cone constitute the results of
this work.

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CENTRIFUGAL CASTING OF FLANGED BRANCHES

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In the Královopolská strojírna centrifugal casting of
flanged branches of cast steel has been developed and opera-
tionally introduced. These branches actually are a joint of
the neck-type flange and a reinforced branch, which makes it
possible to dispends with the reinforcing ring of the branch
and its pressure test for tightness. By the application of this
method, a considerable quantity of fluid metal and man hours
spent on maching and welding are saved. The cast flanged branch
is machined on the inner diameter, packing surface, on the
outer surface only for the weld, and the openings for the bolts.
These branches can be welded right into the shells of vessels.
For welding, even an automatic welding machine can be used.
Centrifugal casting is performed by a special machine into
moulds lined with false sand cores, the number of revolutions
being comparatively high. The mechanical values of the castings
fully come up to forgings, as regards compacting of the steel
by the centrifugal force. Chemical separation in alloyed steels
too, is insignificant and can be kept within the range of the
specification for the composition of the steels. A slight in-
crease in alloying additions on the outer periphery is of ad-
vantage in respect of both strength and weldability. All rota-
tion forms with an inner cylindrical opening and/or bimetals,
too, can be cast by the same methods.

USE OF RUST-RESISTING STEELS IN THE CONSTRUCTION
OF CHEMICAL EQUIPMENT

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The authors deal with the problems of the correct choice of rust-resisting steels for given corrosive environments and service conditions with regard to the technological aspect of design and construction of chemical apparatus with a view to achieve maximum service life.

Rust resisting steels destined for the chemical industry can be devided according to their functions. They are used to ensure the purity of a product in respect of the iron content and the resisting power of the surface of the wall, for a less aggressive medium, should the occurrence of intercrystalline corrosion be given, for a an aggressive medium which, however, warrants the possibility of passivation of the material, for an aggressive reducing medium with the possibility of the occurrence of point corrosion, for chemical apparatu over 400°C, where thermal stress is still added to chemical influence, and for chemical apparatus operating at low temperatures.

The authors present an analysis of the use of rust-resisting steels by practical examples and deal with the prospects of improving the correctness of the choice of rust-resisting steels seen from the viewpoint of further new types of rust-proof steels distinguishing themselves by their economy, developments in improving the technological operations in the manufacture of apparatus, consistent following of the behavior of the material in service, its service life, and the perfect organization of the work of the material expert in rust-resisting steels.

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DEVELOPMENT AND PRODUCTION OF TWO-LAYER WELDED
HIGH-PRESSURE VESSELS

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The development of strip-wound high-pressure vessels
recently carried out in Královopolská strojírna as well as
experience in foreign countries show the obsolete idea of
this -. once very famous - design. Numerous defects in strength
which, due to multiple static indeterminateness of the wound
layers cannot be completely removed was an impulse to further
intensive development in this field. The new idea of combi-
ning the advantages of compact and strip-wound high-pressure
vessels was put into practice. This new idea in combination
with the most recent welding technology enables the production
almost without any limitations that were originally impera-
tive. Important features of this new design are little expen-
diture of labour, short production period, it may be easily
computed and is very advantageous in service. The author
reports in this paper the individual production stages and
results of tensometric measurements.

THICK STEEL SHEET CLAD WITH RUST-RESISTING STEELS

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A survey of methods for the production of clad sheet by pressure welding, hot rolling-on, combined casting, diffusion joining and facing is given. The influence of production methods on the properties of clad sheet is dealt with.

The conditions for joining two metals in the cladding process and the influence of diffusion on the strength of the joints and the character of transient structures are discussed.

The course of the diffusion of carbon from the parent into the cladding steel in the conditions of the production of clad sheet by combined casting and rolling of combination cast ingots: the influence of temperature, time of heating and rate of chilling on the course of the diffusion of carbon, and the quality of the produced clad sheet are dealt with.

Temperatures ranging from A_1 to A_3 and temperatures higher than $1000°$ Centigrade constitute an unfavourable temperature zone for the course of diffusion. If the times of heating in these temperature zones are long, the depth of carburization reaches up to 50 per cent of the thickness of the cladding layers.

The properties of clad sheet produced by combined casting are discussed.

The possibility of using clad sheet and the achieved savings in alloying elements are also dealt with.

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INFLUENCE OF SOME DESIGN AND OPERATING CONDITIONS
UPON THE HEAT EFFICIENCY OF REFINERY HEATERS

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The computation of tube heaters for the petroleum and coal industry is very difficult and therefore, by means of the up-to-date calculation methods it was practically not possible to find more exact numerical relations of heater efficiency and bridge wall temperature on individual design factors and operating conditions.

On the basis of Bělokoň's analytical calculation method a computation program for electronical digital computer Elliott 803 was devised. The use of this digital computer enables to carry out a large number of calculations with a high accuracy. This computation program was applied to precise the correlations between some selected operation variables and design factors on one side and heater efficiency, heating oil consumption, bridge wall temperature, outlet temperature of flue gases, heat absorbed in the radiant and convection sections, tube heat transfer rate, tube skin temperature in radiant section and of some other datas on the other side. As operation variables air excess, heat load, inlet and outlet temperatures of the medium and pressure and steam atomization of heating oil was studied. From the designers point of view the influence of the radiant effective surface ratio to the total wall area of the radiant chamber was examined.

From the obtained correlations some important conclusions were deduced for the economical design of refinery heaters.

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WELDING PRACTICE IN THE CHEMICAL EQUIPMENT MANUFACTURE

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A large number of chemical processes require a specialized equipment. Nowadays a vast interest is concentrated on pressure vessel manufacture. Thick-walled pressure vessels (wall thickness exceeding 60 mm) are made both from carbon and alloy steels.

There are many problems encountered in the manufacture and especially welding problems are discussed from the technological point of view. These problems cover e.g. the selection of an appropriate type of joint, bevelling operations, the choice of a corresponding filler metal as well as welding and heat-treating procedures. Some results of mechanical and non-destructive tests and microscopic examinations are mentioned.

An account is given of methods used in welding vertical and horizontal joints as well as herispherical heads in the manufacture of pressure vessels at Královopolská strojírna.

The lecture is closed by some remarks to future trends in welding techniques applied in the chemical plant manufacture.

DESIGN OF MIXERS WITH ROTATING PADDLES

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This paper presents the results of research work on
mixer design in accordance with the quantitative efficiency
expected from the hydrodynamic regime. The mixing of Newtonian
liquids by means of rotating paddles within the turbulent
region is dealt with.

A description of developed testing apparatus, and
instruments for measuring the moments of torsion in model
paddles is given. The applied system excludes entirely the
influence of the mechanisms' passive resistance.

The author puts before the specialists a theoretical
analysis of the speed correlations between the blade and the
liquid in connexion with the power-input to the paddle. As far
as experimental facts are concerned, the values of Euler
criterions specified for a large number of paddle types are
compared. Further the mutual dependence of Euler and Reynolds
criterions for turbines in the given geometrical arrangement
as well as the various correlations between the container and
paddle diameters are mentioned.

The author also states some facts found to be important
in the construction of mixers with rotating paddles.

WELDING TECHNIQUES APPLIED TO ALLOY STEELS
IN THE MANUFACTURE OF CHEMICAL EQUIPMENT

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The use of high-alloy steels as material of chemical
plant construction is increasing. Chrome-alloy steels or
steels containing other alloying metals are used e. g. in
hydrogenation plant, where hydrogen corrosion occurs due to
the simultaneous effect of pressure and temperature. In our
country these steel grades are marked as Steel 15420 (0,2%C,
0,4%Mn,3%Cr,0,5%Mo,0,5%W,0,8%V). On account of some difficul-
ties met in welding this steel, the resistance welding proce-
dure was recomended. In some instances the manual arc welding
was used and satisfactory results were obtained.

In other types of hydrogenation equipment, stainless
steel grades CrNi 18/8 are used. This steel is subjected to
a special annealing pretreatment to prevent damage caused by
intergranular corrosion. Welding is done by means of electro-
des with limited ferrite contents.

Vessels specified for processing crude oil with high sul-
phur contents are lined with Monel sheets. There are great
difficulties encountered in welding these materials, because
the electrodes are susceptible to porosity. Some improvement
was achieved by means of electrodes developed in ŽAZ Works at
Vamberk which enabled to obtain a satisfactory quality of the
weld metal.

INVESTIGATION OF CYLINDRICAL SHELLS
AND TUBES OF LARGE DIAMETERS

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This report presents analytical and experimental inve-
stigations of horizontal cylindrical shells.
In the first part a ring reinforced with rods is solved.
The calculation is shown and some variants of stiffeners are
compared. As from the statical point of view the investigated
system is statically interminate, the method of forces is
used. Instead of the usual way of calculation the basic system
is chosen in the form of a closed ring, not of an open one. In
this way the number of unknown quantities is reduced. To simpli-
fy the setting of canonical equations, the displacements for
the basic system (the closed ring) are fixed in tables. The
calculations were carried out by means of the digital compu-
ter "Minsk".
In the second part the influence of a concentrated load
applied to the shell by means of a ring is investigated. The
results of measurements on cylindrical vessels with the dia-
meter of Ø 1500 mm, wall thickness = 3 + 5 mm and length
6 + 16 m are presented.
The aim of the experimental research was to find the
actual local stability of the sheet affected by inaccuracies
in production, determining of stresses in the point of action
of concentrated loads and verify the limit state of the whole
vessel reinforced with rings. The report is concluded by a
comparison of experimental and calculated results.

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LIMIT STATES OF STRENGTH OF LARGE BODIES AND VESSELS
SUBJECTED TO STRESS AT REDUCED TEMPERATURES

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This paper deals with the influence of the dimensions
of a body on its strength. The author discusses the problems
of determining the dimensions of large bodies, in particular,
of those that are exposed to the influences of reduced tempe-
ratures and describes a case of instantaneous failure in the
limits of plastic deformation of the material. The causes of
brittle fracture are explained with regard to the energy of
pressure, together with the coefficient relating to size,
and with regard to the influence of triaxial stress.

ON THE ELASTIC STABILITY OF APPARATUS USED IN CHEMICAL ENGINEERING

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The reduction of the weight of steel and, in particular shell constructions has made it necessary to use steel of higher mechanical values. In addition to the heretofore current aspect of strength, it is necessary to investigate the shell constructions used, such as columns, storage tanks, etc., especially with regard to their stability. In the foreground stands the solution and appreciation of the stability of a cylinder loaded by axial pressure and bending, and in either case with and without internal overpressure. This applies to the work load of a column. In general, the linear theory has been used for solving problems of stability, which, however, will not do if cases of more secondary shapes are involved. In these cases it is necessary to use more precise terms for the description of deformation. Besides, relative deformations will become functions of the second degree of the derivation of deflections. Another explanation of the behaviour of a cylinder not subjected to axially forced internal overpressure is found in the derivation of the theory of great deflections, which includes the influence of internal inaccuracies with regard to the plastic behaviour of the shell.

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TRENDS IN THE DEVELOPMENT OF ELECTRIC CARBIDE FURNACES

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In the design of electric carbide furnaces there exist two principal trends:

1/symetric furnaces with a round tank and round electrodes arranged in a triangle,

2/asymetric furnaces with a rectangular tank and square electrodes arranged in a row.

In either case, the furnaces are covered and their design is such that they should work with a maximum output of 40 to 60 MVA.

On the basis of calculations and theoretical consideration, as well as of practical experience, the author compares the advantages and the disadvantages of both systems and arrives thus at recommendations for the choice of the right system for various concrete cases (according to the further use of the carbide and the possibilities of electric power supply and, finally, according to the quality of the raw-materials).

CORROSION RESISTANCE OF NITRIDED TITANIUM

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Corrosion resistance of nitrided titanium in environments
of sulfuric and hydrofluoric acids of various concentrations
at room temperature has been studied and compared with the cor-
rosion resistance of pure titanium. The kinetics of corrosion
has been determined. In all the corrosive media tested, nitri-
ded titanium exhibited higher corrosion resistance than pure
titanium.

ANOMALIES IN THE COURSE OF PRESSURE FILTRATION AND THEIR EFFECT ON THE FILTER PRESS CONSTRUCTION

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The relations between the filter press output and the filter cake thickness as they result from the general theory of filtration showed on the occasion of experimental verification at operational scale to be incomplet as there were anomalies in the course of dependance of filtration rate reciprocal value on the discharged filtrate volumen.These anomalies were neither described in the literature nor evaluated.

The proper filtering process is finished when the filter press chambers are filled up.Nevertheless a farther cake dewatering may be still possible.An individual technical and economical analysis shall decide about the suitability of filtering process up to the compression range.For the determination of optimal conditions of the filter press operation the adequate relations are derived which also respect the regime of filter press filling.According to these relations the optimal working pressure has to be determined as with the increasing pressure the investment costs will be reduced but the energy consumption will rise.

EFFECT OF IMPERFECTIONS ON CRITICAL LOAD OF THIN
CYLINDRICAL SHELL SUBJECTED TO SHEAR AND NORMAL LOAD

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The paper deals with the subject of the influence of
initial imperfections from exact form on the value of criti-
cal load of a segment of circular cylinder subjected to nor-
mal load uniformly distributed over the whole surface and to
shear stresses acting along the edges.

On the basis of differential equations of the nonlinear
theory of shells presented by A. S. Wolmir, the approximate
solution of the problem has been found by means of Bubnov-
Galerkin's method.

Numerical examples were considered for two cases of cy-
lindrical shells with different radii of curvature. The
results indicating the overcritical deflections of shells as
the function of applied load and initial deflection were
plotted.

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ON PROBLEMS RELATING TO HARDENING OF RUST RESISTING STEELS

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Three different types of rust-resisting steel for hardening were tested. One of them, type 10Cr17Ni7AlTi, belongs to the martensite, and the remaining two types, that is 8Cr16Ni7Al and 10Cr16Ni5Mo, belong to the semi-austenitic steels.

These steels were subjected in the various stages of heat treatment to metallographic, mechanical, physical, and corrosion tests. In spite of the fact that steels were involved which are used above all because of their high strength and resistance to corrosion, their mechanical properties at high temperatures were also determined.

Rust-resisting steels possess a series of good properties when being hardened. Besides fair resistance to corrosion, they reach higher mechanical properties than the common rust-resisting austenitic steels. Upon annealing, reaching melting point, these steels can easily be machined and welded. Thus can be made, without difficulties, even very complicated parts, which achieve their final strength and resistance to wear, only after mechanical completion of hardening, whereby, unlike the temperable chrome steels, no danger of cracks or deformation after hardening arises.

FAOLIT - CONSTRUCTIONAL MATERIAL FOR THE CONSTRUCTION OF CHEMICAL EQUIPMENT

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Besides metals, plastics are more frequently used today as acid-proof material for the construction of chemical equipment and apparatus which are immediately exposed to chemical action. Among these plastic materials those that can be used in self-supporting design occupy a special position. The author describes the acid-proof materials Faolit A and Faolit T which have been used in the Czechoslovak Socialist Republic for more than five years and this have yielded valuable practical experience.

Faolit is a mixture of phenolformaldehyde resin and asbestos or graphite. Lately, the testing of coiling Faolit tubes, reinforced by interlayers of glass-textile, has been completed as the latest advance in technology. Several examples of using Faolit in chemical engineering are quoted.

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FOUNDRY CHARACTERISTICS OF STAINLESS STEELS WITH REDUCED NICKEL CONTENTS

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Economically alloyed FeCrNiMnN-base and FeCrMnN-base austenitic stainless steels (of the types Cr18Ni5Mn8N and Cr18Mn15N, respectively) and chromium-nickel double-phase (austenite – ferrite) steels of the types Cr21Ni5,Cr21Ni5Ti, Cr21Ni6Mo2 and Cr21Ni6Mo2Ti were developed for castings of fittings, pumps and other machinery for various corrosive media, where chromium-nickel austenitic stainless steels had been used hitherto.

From the point of view of casting technology, the properties of double-phase chromium-nickel steels are somewhere half-way between those of chromium stainless steels.Among the economically alloyed austenitic steels, the steel Cr18Mn15n is, in respect of its casting characteristics, nearer to this type of classical CrNi steels, while the casting characteristics of the steel containing 5% Ni (type Cr18Ni5Mn8N), are somewhat inferior. Oxygen flame cutting may be used for removing risers and runners. All of the investigated types of economically alloyed casting steels may well be welded by means of electric arc without preheating, using austenitic electrodes of current production. In machining, substantially higher cutting speeds may be used for the double-phase steels than for the austenitic steels alloyed with manganese and nitrogen.

ON THE CHOICE OF MATERIAL FOR THE CONSTRUCTION OF CHEMICAL EQUIPMENT

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The authors deal with the reduction of cost by the optimum choice of material. In non-corrosive environment the possibilities of suitable application of particular material can be limited by mechanical and thermal requirements. A simple diagram can be drawn up for selection of material used for the construction of apparatus. Supplementary diagrams allow for a comparison of apparatus made of the proposed material with the lowest material cost and/or with the lowest weight.

The influence of the production technology /e. g. welding, heat treatment/ of the particular kinds of steel on drawing up these diagrams is followed.

A complex evaluation of the whole problem in drawing up a selective diagram has excluded subjective influences in the choice of material for the manufacture of chemical equipment.

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A CONTRIBUTION TO THE PROBLEMS OF WELDABILITY OF AUSTENITIC STAINLESS STEELS OF THE TYPES Cr18Ni5Mn8N AND Cr18Mn15N

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The weldability of economically alloyed stainless steels of the types Cr18Ni5Mn8N and Cr18Mn15N was examined by means of hot-cracking tests, intergranular corrosion resistance tests and from the point of view of structural changes that may occur in the course of welding and in long-term service at elevated temperatures.

These two types of steels possess a good metallurgical weldability. Cracks in the region weld metal - base material have not been indentified by anyone of the tests recommended for austenitic steels. This has lead us to the conclusion that the weldability of steels of the types Cr18Ni5Mn8N and Cr18Mn15N is superior to that of CrNi-base steels. Positional weldability, too, according to the results of welding tests in a number of engineering works, is in these steels not inferior to that of steels of the classical Cr18Ni9 type.

Valuable results have been obtained also in tests of mechanical characteristics of welds of these new materials at low temperatures (-70°C).

The tests have confirmed the possibility of using also for such applications where welding of thick plates cannot be avoided.

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MULTIWORM-TYPE HEAT EXCHANGER

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For the treatment of various kindes of granular, pasty and highly viscous material multiworm-type heat exchangers can be used to good advantage. In them the following processes take place: mixing, transfer of heat, transfer of material, and chemical reactions taking place in homogeneous and heterogeneous media. Designs where the blades and the jackets form heat-exchanging surfaces appear to offer the most advantageous and universal solution. The blades of the neighbouring worms mutually drop into the gaps between the threads and thus they are cleaned, and the material is mixed at the same time.

Heat exchangers with two and four shafts, blade diameter 70, 100 and 200 mm, total heat-exchanging surface from 0,3 to 23 sq.m. have been tested for various kinds of material and at different loads, too. The test equipment has furnished the coefficients for heat transfer from exchange into the material, in drying sand and sulphide ores up to 160, in smelting sulphide ores up to 220, and in melting sulphur up to 250 kcal/sq.m.hr. °C. In comparison with other heat exchanging equipment,used in the present time, these test designs distinguish themselves by their great economy.

A CONTRIBUTION TO THE EVALUATION OF TENSOMETRIC MEASUREMENT

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The paper deals with certain questions connected with the evaluation of tensometric measurement. It contains a draft of intersection nomographs for determining the rates and directions of the principal enlongations in measuring with rosettes: the chosen coordinate system allows for plotting into the nomographs lines of equal stresses for the quick information of the kind of stress. In addition, the influence of transversal sensitivity of the tensometers on measurement in the principal and general directions is discussed. For the compensation of this influence evaluation charts can be used which contain the respective correction: charts for two types of tensometers of Czechoslovak make are attached.

THE SAFETY OF PRESSURE VESSELS WELDED FROM STEELS
OF HIGHER YIELD STRENGTH

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The function of "plastic knucle" is emphasized with re-
gard to the safety of pressure vessels which are designed
according to the present Code requirements and constructed
from steels of boiler quality.

A comparison is made of results from destruction tests
of pressure vessels constructed from carbon or lowalloy steels
of boiler quality and from carbon or lowalloy steels of higher
yield strength.

It is shown, that the brittle behaviour and the value of
static loading pressure at destruction of pressure vessels
made from steels of higher yield strength does not correspond
to the ultimate tensile strength of material used.

This phenomenon is explained with different plastic pro-
perties of mentioned steels.

The substantial influence of unhomogenity of welded joints
is shown.

It is adverted, against to usual Code method designing
of pressure vessels, that there is necessary to consider still
farther boundary conditions of pressure parts made from steels
of higher yield strength during its designing.

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THE PRESENT-DAY STATE OF DEVELOPMENT
OF CENTRIFUGAL COMPRESSORS IN ČSSR

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The report describes new types of centrifugal compressors developed in ČKD-Praha, national enterprise for the purpose of the chemical industry for compressing various gases. In the last few years, centrifugal compressor refrigerating systems have also been gaining application in the chemical production of basic raw materials and, for this purpose, some designs of the machines working with propane and ammonia will be shown.

The solving of several problems connected with the development of these machines will be described, for example the problem of a right project of internal working parts of the machine with regard of low sonical velocities of the gases as well as the problem connected with the hermetic sealing of the shaft at high circumferential speed etc.

Finally the report deals with special technical solutions which automation of centrifugal compressors, controlling, checking and regulation of the parameters required.

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TENSILE STRENGTH TESTS OF FLANGED JOINTS

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From a series of profiles of weld-on flanges designed on the basis of modern methods (Schwaiger, Haenle) for heat exchangers of the fluid-type system - fluid for a range of nominal inside diameters N.I.D. 150 to 1000mm, at maximum working pressures of 10 kp/sq.cm. and 25 kp/sq.cm., the flanges, for an instrument diameter N.I.D. 300 and N.I.D. 600 mm, maximum working pressure of 25 kp/sq.cm., are tested with the aid of an electric extensometer. The results of these tests are then compared with the calculations.

The tests include flanges that are of the same and/or similar dimensions as weld-on flanges where the flange sheet is joined to the conical socket with the aid of a K-seam. By comparing the results of the tests for both types of flanges, we receive the rating of the weld-on flange. Conclusions for the standardization of vessel flanges have been drawn from these tests.

SYNTHETIC CARBON USED AS PACKING FOR OXYGEN PISTON COMPRESSORS AND FOR PUMPS FOR LIQUID OXYGEN

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Compressors where synthetic carbon, serving as packing for glands and piston, is used for dry lubrication have been manufactured in the German Democratic Republic since 1935. Until the year 1949 only piston compressors for air up to a delivery pressure of 4 atm.g. were turned out.

In most processes in the chemical industry oil is unwelcome as a lubricant, because it must be removed again by additional equipment. When compressing pure oxygen up to 165 atm.g. water is exclusively used for lubrication.

For packing the pistons, leather, special rubber, or vulcanized fibre are used as sliding material. The low accessible speeds of the piston necessitate large dimensions of the machines. Moreover, these packing materials have a short service life.

Since these machines play an ever-increasing role in oxygen metallurgy and in oxygen chemistry as circulation and filling compressors and also as pumps for liquid oxygen, tests were carried out to determine the properties of synthetic carbon, in the solid and the powdered state, used for packing oxygen compressors and pumps for liquid oxygen, in dependence upon temperature and pressure.

SCIENCE AND PRACTICE IN THE FIELD OF CHEMICAL EQUIPMENT

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In the field of chemical equipment the practice is far ahead of the science.While the designs in the compulsory engineering are in general technically or even scientifically proved,the chemical equipment are after all influenced by individual demands of the chemical industry.First,in the last three decades a markable step in theoretical understanding the fundamental operations through many scientics starting by Nusselt was done,by studying the laws of heat transfer,however,the vapourization and condensation are satisfactory solved only by means of empirical equations.Also in the field of absorption and destilation,where the process of mass transfer take place the scientific works are at the beginning.Although the province of "Construction of chemical plants" is able to comply in the practice every demand of the chemical industry.

To enable the connection of science and practice,it is necessary to make an agreement between the chemical and mechanical technology.If,with the methods of science the chemical and physical process will be translated to the fundamental process of heat and mass transfer and if the materials of design would conform the technological conditions,new optimum designs of efficient apparatus could be arise.

CENTRIFUGAL PUMPS OF PLASTICS USED IN THE CHEMICAL INDUSTRY

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The author describes the development of and the experience gained from the operation of a centrifugal pump made from polyethylene and polyolefine mixtures which were developed in the Research Institute for Manufacture of Plastic Materials, Budapest, Hungary. Only highly resistant plastic materials come into contact with a pumped aggressive liquid. The shaft is provided with a mechanical seal whose sliding ring is made of graphite impregnated with polyethylene.

The output of the pump, at 2900 r.p.m., is 120 litres/min., its delivery head 12 m. Since 1959, these pumps have been used to good effect in the chemical, food-stuff, and pharmaceutical industries, as well as in electrodeposition. The pump distinguishes itself by economy in service.

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CERTAIN PROBLEMS RELATING TO THE CALCULATION OF FLANGES

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One of the oldest and at the same time most frequently occuring elements in the construction of pressure vessels and piping is the flange. The endeavour to calculate its strength certainly is as old as the flange itself, but the first, practically usable calculation, which, at least partially approaches reality, was worked out by Dr. Bach in the early years of this century. Later, the number of useful or less useful methods of calculation increased, in particular, after the shell theory had been introduced into the calculation treatment of pressure vessels, which made it possible from the very beginning to establish a reliable method of calculating the plain face flange which is the simplest next to the rotary flange. The question of the neck-type flange, however, still remained unsolved up to the time when scientists headed by E. O. Waters embarked upon this job and worked out a very perfect method of calculating the neck-type flange, a method tallying very well with the performed experiments and being quick and well applicable in practice. On the basis of this method of calculation a look into the process has been enabled that, during loading, take place in the flange of this type. Moreover, the possibility has been given to establish the relationship that permits to create a suitable shape of the flange so as to be advantageous both from the aspects of strength and economy. It is also of interest to compare Waters' method of calculation with the new proposal of the standard for the calculation of flanges DIN 2505.

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PRINCIPLES OF STRENGTH IN DESIGNING CHEMICAL EQUIPMENT

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The respecting of the principles of statics, elasticity and strength in designing chemical equipment, in particular, vessels, leads to the possibility of creating designs and constructions distinguishing themselves by their economy. Vessels of all types form the major part of all chemical equipment and apparatus and, therefore, it is necessary to pay particular attention to economy in their design and construction. For the design to find optimum utilization, it is necessary that, in addition to serving its purpose, its aspect of strength should also be successfully tackled in the best possible way. Designs and constructions of various shapes can frequently serve the same functional purpose. Some of them have more advantages, whilst others are less advantageous, taken either from the viewpoint of technology, or from that of material consumption. In this contribution several examples are given, where the respecting of the principles of strength in design and construction has resulted in savings in material.

MULTILAYER HIGH PRESSURE VESSELS MADE THROUGH HYDRAULIC DEFORMATION OF THIN SHELLS

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The ever increasing demands made on the fabrication of high-pressure apparatus have necessitated new solutions of design and production. In this paper, the author discusses briefly several most widely used conceptions. His description deals with a new method of production, developed in Poland, of multilayer high-pressure vessels. This method is based upon hydraulic deformation of the individual thin-walled sheet laminations which are freely fitted into one another. Upon completed fitting of the individual laminations, prestressing follows effected by a method similar to auto-frettage. So constructed cylindrical thin-walled sections can be welded up to whatever lengths. The transverse weld does not require any further annealing, since this last operation can be performed right during erection. All tests have yielded positive results, thus making this type cease to be one in development.

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PLANT FOR THE PRODUCTION OF SYNTHETIC RESINS

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The technical production of resins forming through poly-
condensation requires special auxiliary plant. The author
describes the design, lay-out and function of such plant.
Special attention is paid to the analysis of the heating
technique. Electroinductive heating and the extensive auto-
mation of the production process made possible by the former
are dealt with in particular.

CALCULATION OF FILTRATION BY MEANS OF THE
COMPRESSIBILITY TEST

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The behaviour of an idealized non-continuous compressible medium, mechanically pressure loaded, was experimentally followed up. The results of the evaluated measurements, carried out with the aid of the analogy between the hydraulic and the electric resistance, were compared with those found on the filter cakes. The observations made it possible to set up the laws of the laminar flow of the liquid through a non-continuous compressible medium and to use them for solving the common case of the flow of a liquid through gradually increasing compressible filter cake.

By suggesting and working out a compressibility test method, the serviceableness of a simple filtration experiment for the solution of filtration problems has been increased. A method of calculating an ad lib filtration process has been elaborated.

The theoretical conclusions were confronted with the results of laboratory measurements and good accord with reality was achieved.

ON THE WELDABILITY OF STAINLESS STEELS, TYPES CH 17
AND CH 17 T

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On the basis of actual research work and known hypotheses, elucidating the occurence of temper brittleness, the decrease of plasticity in the area thermally influenced by the weld in stainless chromium steels, types CH 17 and CH 17 T, is explained.

All experiments performed for the purpose of increasing the notch toughness in this area of little significance, because the elimination of carbides and the structural changes that take place in the thermal operation of welding, bring about lasting changes in brittleness. The lower limit of cold brittleness (approx. $1 kgm/cm^2$) is already reached at room temperature. Notch toughness of about $3 kgm/cm^2$ is reached only at an operating temperature higher than $50^{\circ}C$.

After annealing, the welded joints show a great angle of bend, but an equally low notch toughness, which makes the designers doubt, whether it is expedient to use steels of the type CH 17 and CH 17 T.

The performed analysis of the above mentioned items of information and the achieved results of actual research as well have helped to asses the expediency of the examined steels for building welded constructions operating in various conditions.

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THE WELDABILITY OF MATERIALS FOR THE CHEMICAL INDUSTRY

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The specific conditions of certain chemical processes
often require intricate equipment,whose fabrication and as-
sembly could be hardly done without welding.

In the chemical industry plain and alloy steels,non fer-
rous and light metals as well as their alloys,titanium,metals
with special properties and elevated corrosion resistance and
finally plastics may be considered for the manufacture of the
necessary production facilities and accessory equipment.The
properties of the said metals change during welding in the heat
affected zone in a different way,according to the type of ma-
terial and the welding technology.

The changes usually make themselves felt by the decrease
of certain important mechanical properties and of the resistan-
ce to the aggressive effects of reactive media.

The said changes are caused by structural changes owing
to welding or service conditions.Their control will extend the
conception of weldability also from the standpoint of corrosion
resistance.

WORKING OUT OF DESIGNS, METHODS OF CALCULATION
AND MODELLING OF AIR SPRAY DRYING PLANTS FOR
DRYING OF LOOSE MATERIALS

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On the basis of the analysis of the existing methods of
drying loose materials in lofts and semi-lofts, it was esta-
blished in the conclusion of experimental research with model
and industrial equipment that one of the most effective methods
is that of drying in air spray drying plants which posses a
number of advantages over other drying apparatus. In the
lecture delivered to the Congress the question of the choice of
a rational scheme of the drying equipment is solved and the
description and analysis of the operation of a new highly effi-
cient design of an air spray drying plant for deep drying up of
the moisture of semi-products and dyes are given.

On the basis of examing the influence of the parameters of
the process on the integral effect of drying, the principal laws
were laid down determining the optimum conditions for the pro-
cess of drying in air spray drying plants, and the general cri-
terion equation for the calculation of the quoted moisture, ba-
sic dimensions of the drying plant and its capacity was deduced.

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EXPERIENCE IN WELDING SPACIOUS PRESSURE VESSELS

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The need to make a spacious thick-walled pressure vessel, with exacting demands upon the basic material and the welded joints, has necessitated to limit the weight of the steel ingots of class 13 (Czechoslovak Standard) to 40 - 50 tons and to use automatic welding techniques in the maximally possible measure.

Electroslag welding guarantees the highest productivity of labour, achieving at the same time the required qualities of the welded joint.

This paper shows how it is possible to weld a cylindrical and a conical ring, of a diameter of approx. 5000 mm and 170mm thickness, by means of longitudinal electroslag welds of individual segments. Moreover, it illustrates the method of welding cylindrical rings by means of a peripheral electroslag weld in the section of the vessel.

The work described in this paper shows the feasibility of applying the techniques of electroslag welding in the fabrication of spacious pressure vessels.

THOUGHTS OF COOPERATION BETWEEN MANUFACTURE OF APPARATUS AND FUNDAMENTAL RESEARCH IN NATURAL SCIENCE

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In search for optimal solutions engineers very often meet with unsolved problems of natural science.Though,from the standpoint of enlarging our physical knowledge,these often are of second-class importance,they get principal importance in respect to their economic value.

Examples taken from the practice are presented.On the other hand,in the domain of natural science,there has already been reached a certain knowledge which is applicable to the manufacture of apparatus with promising succes.But engineers do not yet fully understand and suffiently realize this knowledge.

A solution of these difficulties is seen in making engineers much more experienced with physico-mathematical methods as it has been up to now and in evolving a complete theory of processing technics.

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EFFECTS OF ADDITIVES ON PROPERTIES OF RIGID PVC
PART 2. CORROSION RESISTANCE

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The effect of corrosion resistance of small amounts of additives of rigid PVC was studied. For these experiments polymers of Czechoslovak and foreign origin were used, containing all fundamental types of plasticizers and other additives. Test samples. i.e. bodies used for estimation of tensile strength, were exposed to the influence of corrosive . medium during 90 days at temperatures of 20° and 40°C. Corrosive media were: distilled water, sulphuric acid 80%, nitric acid 40% and sodium hydroxid 20%. It was found that the presence of plasticizers considerably influences the corrosion resistance of rigid polyvinyl chloride, the influence being, however, a specific one.

EXPERIENCE IN THE MECHANIZATION AND INTENSIFICATION OF THE FILTRATION PROCESS OF A HIGH-DISPERSION SUSPENSION IN THE ANILINE DYE INDUSTRY

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The problem of the mechanization of the filtration process of very thin suspensions, requiring careful washing, has not been solved for the time being. Mechanized filters and centrifuges which are currently manufactured are meant either for filtration of very grained suspensions, or for cleaning thin suspensions by filtration, in which the filter cake is no valuable product and can be removed by washing. In recent years NIOPIK (Research Institute of Organic Intermediates and Dyes), together with the Ukrainian Scientific Research Institute of Chemical Engineering, has been carrying out tests using a mechanized and automatized filter press in the aniline dye industry. In the results of this work the scope of the application of this apparatus, the basic indices and peculiarities of the work of the filter press in filtering various kinds of suspensions (cake moisture, filter output, quality of filter washing and regeneration of filter cloth, air and electric power consumption) were determined. The results of this work are then compared with analogous results achieved in the work with pressure disk-type filters; on the basis of laboratory experience, practical methods for the choice of filter type and optimumconditions for its operation are worked out according to model plants.

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SOME CHARACTERISTICS OF AUSTENITIC Mn-Cr STEELS WELDING

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Austenitic Cr-Ni steels are important structural materials for various branches of the chemical industry. The endeavour to save nickel led to the use of the economic Cr-Mn-Ni steel throughout the world, mainly of nickelfree Mn-Cr steels. In Czechoslovakia, chiefly the nickelfree types MnCr/Ti 17/7, MnCrV 17/10, MnCrMoV 17/7 and MnCrV 17/17 are being used.

Welding of these steels involves a lot of new metallurgical problems. However, test results proved that the said steels show good flash weldability, if special filler material is used, taking into account the metallurgical characteristics of austenitic Mn-Cr steels. Desoxidation of the molten pool by means of silicon and carbon contents in the range of 0,08 - 0,14 % used to give crackfree, compact joints. In critical cases, small additions of iron powder in the electrodes coating contributed to the density of the joints. Scalling loss resistance of the joints depends mainly upon the ratio of carbon and silicon in the weld metal. For the stabilization of the weld metal Nb + Ti may be used; it is, however necessary to avoid contents of less than 0,60 % and more than 1,20 %, without considering the carbon contents.

As to resistance welding of the said steels, tests are being carried out.

EFFECT OF ADDITIVES ON PROPERTIES OF RIGID PVC
(MECHANICAL PROPERTIES)

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The mechanical behavior of rigid PVC for constructional purposes has been studied with a special view of long - time creep - repture strenght.In this connection,the influence of small amounts of additives has been studied,as well as the difference in the behaviour of materials prepared from emulsion and suspension polymers.It has been found that in the field of materials studied it is not possible to attain,by means of additives,a substantial improvement of mechanical properties because

1. brittlenes is increased with increasing strength
2. with increasing ductility the susceptibility to creep is increased in connection with the decrease of "mechanical thermal resistance".

It is pointed out that it is absolutely necessary that the composition of rigid PVC intended for use in chemical appliances be strictly specified;for constructional purposes, again it is not recommended to use rigid PVC containing small amounts of plasticizers.

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ELECTROLYTIC COATINGS OF ZINC-NICKEL ALLOY AS PROTECTION
AGAINST CORROSION OF STEEL·PRODUCTS

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The conditions for the joint elimination of zinc and
nickel from cyanide and ammoniacal solutions were examined.
The thin layers obtained from cyanide electrolytes contained
from 0,5% to 2% nickel, from ammoniacal ones from 10% to 30%
and more, the rest was zinc.

Of best advantage are coatings from 10% to 18% nickel.
They are sufficiently tough, considerably more resistant to
corrosion than coatings of zinc itself and guarantee the
anodic character of protection of steel products. Such coatings
of a nickel content higher than 20% are rather brittle.

According to the results of the structural analysis the
electrolytically eliminated coatings of zinc-nickel alloy do
not correspond to the phase diagram of the same alloy obtained
by casting. In most cases, they represent oversaturated solid
solutions of zinc in nickel, with increased parameters of the
lattice of the beta or the gamma phase.

Coatings of zinc-nickel alloy are recommended for the
protection of steel parts against corrosion in an aggressive
atmosphere of increased humidity and polluted by industrial
gases.

WELDING OF STAINLESS STEELS

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The development of the chemical and power industries ne-
cessitates the full utilization of stainless steels which prove
effective at both very low temperatures and high temperatures
over 1 000°C.

Great demands are made on the metallurgy and technology of
welding. Weldability is dealt with from the viewpoint of suscep-
tability to cracks, resistance to intercrystalline corrosion, as
well as from the aspect of structural stability upon influence
by the heat cycle. The question of the sigma phase is dealt
with extra.

Practical welding is described with reference to the gene-
ral principles for welding stainless steels. The technology of
flame welding, electric arc welding with coated electrodes,
submerged arc welding, resistance welding, and special cases
are discussed.

In conclusion, various practical items of information
from the fabrication of welded pressure apparatus are given.

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THE PRODUCTION OF LARGE FORGINGS FROM RICH-ALLOYED
Cr-Ni STEELS

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The production of large forgings from rich-alloyed steels
is joined with problems in connection with lower plastic featu-
res of these steels in their forming.

For operation temperatures above $550^{\circ}C$ are used heat-proof
martensitic steels and for operation temperatures above $600^{\circ}C$
austenitic Cr-Ni steels are used. In recent time large forgings
werw produced also from classical heat-proof steels with a con-
tent of 24% of chromium. In all these steels a second phase may
occur at forging temperatures, which make the meassurements dif-
ficult and in much cases their are impossible. It was proved by
research that the occurence of delta-ferrit in steels with a
12% chromium content do not make the forging more difficult.
Steels with a content of 24% of chromium have in general also
a content of austenite, which makes the forming of large ingots
really impossible. High demands are claimed to the working from
stabilized Cr-Ni steels. Considerable difficulties appear with
carbide-forming stabilizing admixtures. Some ingots of the weight
of 8 tons were forget from these steels, but the production is
still not economical and further research in this field is ne-
cessary.

ECONOMICAL STEELS FOR WOUND HIGH – PRESSURE VESSELS

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There have been developed convenient steels for winding bands, the production of these bands and the conditions of heat method at their winding on bodies concerning wound high-pressure vessels consisting of a basic core tube wound by several layers of shaped winding bands. Constructional MnSi steel was chosen for bodies working in the range up to $200^{\circ}C$. For bodies working at higher temperatures (up to $380^{\circ}C$) there was developed the economical CrV steel, in addition to CrMo steel used in other countries. Comparative laboratory experiments of heat treating according to the conditions of heat method at winding bodies from a temperature above Ac_3 showed that economical CrV steel is more convenient than CrMo steel for its lower hardenability and higher values of plastic properties. For reaching the corresponding strength properties it involves higher austenitisation temperatures with regard to the higher stability of the vanadium carbide. It makes it possible to increase the cooling intensity at winding and in that way also to increase the output of the winding machine; moreover, it is less sensitive for operation deviations from the optimal heat method at winding.

For its good weldability MnSi steel for cold working bodies as well as economical CrV steel for hot working bodies gives high operation security of wound high-pressure vessels.

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HIGH-STRENGTH STEELS

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As regard low-alloy high-strength steels in ČSSR, the aim was to decrease the weight of constructions. The object of study was the increase of the yield point for a number of elements in welded constructions are subjected to tensile stress and their improved properties can be readily utilized. Successively a series of steels with continuously graded yield point 36-45 kg/mm^2 was developed. The development of these steels was based upon the classical St 52 steel on the Mn-Si base. Increase in yield point was effected by adding titanum or vanadium. Thus the steels on the Mn-Si-Ti base with the yield point 36-38 kg/mm^2 and 40-42 kg/mm^2 came into being. The steel on the Mn-Si-Cr-Ti base with its yield point 38-40 Kg/mm^2 ranks between them. The last ling of the series developed is formed by the steel on the Mn-Si-V-N base with the yield point 45 kg/mm^2. With increasing the yield point and consequently decreasing the cross section of the constructional elements, the conditions of the welding technology are favourably influenced. In this connection the question of atmospheric corrosion resistance, which has been solved by addition of copper into the steel of the highest type, is also important.

AUSTENITIC STEEL ON THE Cr-Mn-Ni-N BASE AT LOW TEMPERATURES

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The properties of ^{C}r19Mn9Ni5N steel at very low temperatures are interesting from the point of view of utilization in chemical industry. In wrought condition at $+20^oC$, this steel has the yield point by about 30% higher than austenitic CrNi 18/9 steels so that its utilization at low temperatures presents the possibility to decrease the weight of constructions. At -195^oC the impact resistance of the steel is about $9mkg/cm^2$ and also the ductility and contraction (about 20%) are satisfactory.

The influence of the nitrogen content on mechanical properties at 20^oC was studied for Cr19Mn9Ni5N steel from laboratory heats. It was determined that with increasing nitrogen content the yield point and impact resistance increase; on the other hand the impact resistance decreases at -195^oC.

A similar dependence on the nitrogen content was ascertained for cast Cr19Mn9Ni5N steel by informative determination of impact resistance.

The influence of delta-ferrit on impact resistance was studied and it was proved that the impact resistance of Cr19-Mn9Ni5N steel at -195^oC is practically not affected by its presence.

AUSTENITIC STAINLESS STEELS ON THE Cr-Mn-N BASE

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On the basis of research of metallurgy and constitution of alloys on the Fe-Cr-Mn base with high nitrogen contents the economical austenitic stainless steels 10Cr16Mn15MoN and 10Cr16Mn15Ni2N referred to as N7470 and N7471 respectively were developed.

From the point of view of mechanical properties, the developed steels are characterized by high yield point (more than 40 kg/mm^2) while the plastic properties are comparable with those of classical austenitic stainless steels on the Fe-Cr-Ni base.

For both steels a very good operational and metallurgical weldability by the argonarc method on sheets samples and by hand arc welding on sheet billet samples using the existing austenitic electrodes was proved.

The effectivness of alloying the developed steel by 0,5% Mo (N7470) or 2% Ni (N7471) was verified by determination of the values of critical passivation current density on the basis of polarization curves registered by means of potentiostat and by determination of the corrosion resistance in a series of typical corroding media.

TWO-PHASE STAINLESS STEELS ON THE Cr-Ni BASE

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To substitute the stainless austenitic stabilized steels on the Cr-Ni base, two economical two-phase steels on the Cr21-Ni5 and Cr21Ni6Mo2 base stabilized with titanum were developed. These steels exhibit slightly increased strength but substantially higher yield point values which are nearly double in comparison with corresponding austenitic steels. The optimum elongation values are reached at 45-55 % ferritic phase content in the structure. Also the impact values are satisfactory.

The corrosion resistance of these ferritic- austenitic steels is comparable with corresponding austenitic steels in media where the corrosion occurs in the passive state. Unfavourable influence of lower nickel content is manifested only in the media containing concentrated Cl ions when the corrosion occurs in the active state. Steels with carbon content up to 0,12 % do not show any inclination to intercrystalline corrosion even if they are not properly stabilized.

The steels are subjected to embrittlement at 475°C and manifest inclination to destabilization of austenite. Within the temperature range 550-900°C the precipitation of the sigma phase occurs. At normal temperature and after cold working the stability of the structure is satisfactory.

Steels with ferritic-austenitic structure are characterized by a very good operational weldability. Another important advantage of theirs is also their good machinability by cutting.

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WELDING OF CrMoV AND CrMoWV STEEL PLATE OF GREAT THICKNESS

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⌐ The author describes in his paper new items of informa-
tion which he gained in manual arc welding of CrMoV and CrMoWV
steel plate of 120 mm thickness. In the paper, the reasons
within the welded plates in the zones where critical cooling
rates were reached, are rendered. By means of detail tests on
models and welded plates, the range of critical rates at which
a decrease of the values of notch toughness occurs, was deter-
mined. The region of critical cooling rates was determined by
measurement supplemented by the determination of the values
of notch toughness for the entire section of the welded joint
of 120 mm thickness.

   On the basis of experience verified in the Lenin Works
in Plzeň, the author recommends to weld these steels after
complete heat treatment.

   In the experimental work, the results of which are descri-
bed by the author, the procedure was such as to enable their
general use within the range of structural CrMoV and CrMoWV
steels.

MANUFACTURE OF STAINLESS STEELS

J. Chvojka

Vítkovické železárny

Ostrava, Czechoslovakia

The development of stainless steels during the last
past years. The method of processing classical stainless
steels in electrical furnaces. Some new elements for a more
economical process.

Casting of ingots, their quality with regard to further
treatment. The manufacture of some economically alloyed stain-
less steels. Experiences in manufacturing stainless steels in
open hearth-furnaces. Further trends in manufacturing stain-
less steels.

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THE CHEMICAL RESISTANCE OF ACID-PROOF ENAMELS

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of the Hungarian Academy of Sciences

The chemical resistance of an acid-proof enamel has
been tested with 20% of weight of hydrochloric acid under
pressure in low vacuum at room temperature, furthermore in a
closed recipient heated up to $200^{\circ}C$. The leaching due to
pressures up to about 6 atm increased with relative rapidity,
but above this region up to 40 atm the leaching/pressure plot
rose only very slowly. In vacuum the leaching has a minimum
value. The measurements made in a closed recipient gave a plot,
which had at $80^{\circ}C$ an inflection point. Control experiments -
stirring the solution - showed that this steep gradient is
due to the stirring of the convection currents. The leaching
has been plotted also versus the leaching time.

By means of the spectroscopical analysis of the leached
ions, wetting tests and X-ray diagrams it could be determined,
that there is no qualitative but only a quantitative differen-
ce in the liqr .d phase between the various leaching processes,
e.a. elevated pressures at room temperarue and boiling at at-
mospheric pressure.

MANUFACTURE AND APPLICATION OF TITAN

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Titan is a new material of construction for the chemical industry. Mechanical properties, treating, properties of corrosion and application. Higher corrosion resistance by means of surface treating, especially by oxydation. The properties of the oxydation layer, the laws of its origin and growth. Corrosion resistance of alloys, titan and the importance of influence of little amounts of Pt and Pd.

Some typical examples for applying titan in the chemical industry. The economical problems of semi-products from titan, the relationship of the costs of semi-products and crude. The assumed price in Czechoslovakia, in comparison with the prices of stainless steel. An example of economic analysis of the advantageous application of titan. The necessity of starting the manufacture of equipments, apparatus and their furnitures from titan and its alloys.

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A NEW TYPE OF SPHERICAL REACTOR FOR CATALYTIC REACTIONS
WITH RADIAL FLOW OF FLUID

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The authors describe the disadvantages of existing
reactor types for catalytic reactions in gaseous phase (espe-
cially catalytic reforming, hydrofining etc.). The main dis-
advantages are: a low utilization of the space where high pres-
sure operations take place, difficulties concerning a uniform
flow over surfaces, the necessity of intricate lining and a
non-uniform distribution of the temperature in the shell.
The newly designed pressure vessel is of spherical shape
applying the principle of radial flow of the fluid and has
many advantages: the active pressure space is highly utilized
thus bringing a reduction of the diameter of the apparatus, in-
side lining may be omitted, pressure drop is reduced, the design
is simplified etc. The main advantages of the new design are
hydrodynamic pecularities in connection with the radial flow.
With standard structures and keeping an equal catalyst volume,
an equal inlet velocity and an equal throughput. The average
velocity is only one third of the inlet one. This influences
essentially the overall pressure loss and the time of contact
of the fluid with the catalyst is prolonged about three times.

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MODELLING OF POLYMERIZING REACTORS

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1. The basic condition for creating a series of geometrically similar polymerizing reactors for polymerization of suspensions is to ensure that equal quantities of heat are eliminated from the unit of the agitated volume.

2. During the reaction in geometrically similar reactors and in the same technological regimes, the number of revolutions of the agitator is the only independent variable determining the coefficient of heat transmission from the agitated system to the wall of the apparatus.

3. The increase in the volume of geometrically similar polymerizing reactors causes a considerable diminution of the mean diameter of the particles of the hydrocarbon phase and a steep rise of the agitator input. These factors determine in the end the maximum cubic capacity of the polymerizing reactor.

4. The cubic capacity of the polymerizing reactor can be increased several times by widening the mean temperature difference between the agitated system and the cooling medium. Of course, a considerable increase in the mean temperature difference causes difficulties and reduces the coefficient of heat transmission from the agitated system to the wall of the apparatus.

5. When it is necessary to use polymerizing reactors of great capacity, the change of the technological regime is a necessary condition for the obtaining of a final product of high quality.

HIGH PRESSURE PUMPS AND COMPRESSORS FOR CHEMICAL TESTING PLANT

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Leningrad, USSR

The author deals with the general demands on pumps and compressors for testing plant.

He gives a short survey of the existing designs of high-pressure pumps with respect to their fabrication and use, and methods of output regulation. In addition, he deals with the special features of the designs of plunger pumps with hand and automatic control during operation and with the latest types of pumps developed by the All-Union Research Institute of Petroleum Chemistry.

In the further part of his paper, the author describes the latest types of pumps, high-pressure compressors, and gas-compressing plant on testing plant. The advantages of piston compressors are rather great. In the close of his paper, the author has drawn up a survey of the best foreign-made and Czechoslovak-made compressors of low output and gives an analysis of novel models of compressors developed by the All-Union Research Institute of Petroleum Chemistry.

AIR COOLERS IN THE CHEMICAL INDUSTRY

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It is above all economic reasons that speak in favour of
the application of air coolers in the chemical industry, be-
cause the development of industry demands a steadily increasing
quantity of service water. The essential advantage of cooling
by air lies in the fact that the latter is available everywhere
in a practically unlimited quantity.

The author point out the circumstance that air cooling as
compared to water cooling is the more economical the higher
the outlet temperature of the cooled medium. Therefore, this
method of cooling is recommended, in particular, for conden-
sing substances having a comparatively high boiling point. In
the Hungarian conditions of the prices of machinery and power,
air cooling can be used for substances having a boiling point
higher than $60^{\circ}C$.

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STANDARDIZATION AND TYPIZATION OF CHEMICAL APPARATUS

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The author deals with the standardization and typization
of chemical apparatus, the particular methods and economic ad-
vantages in fabrication and designing.

The basic problems are constituted by the development of
modern plant of a high output seen from the viewpoint of its
shape, arrangement of type series of the most used apparatus,
and the choice of optimum equipment in accordance with produc-
tion-engineering and economic requirements.

The sectional and group arrangement of machinery and
apparatus forms an important item.

In the close of his paper the author deals with the pro-
visions for type projects.

NEW TECHNOLOGY OF FABRICATION OF THICK-WALLED WELDED
VESSELS FOR THE CHEMICAL INDUSTRY MADE OF ANTI-CORROSIVE
AUSTENITIC STEEL PLATES

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The intensification of the processes of chemical technology, in particular, rise of temperatures and pressures, together with increased aggressiveness of environment, necessitates increased thickness of the employed steel plates and the use of non-corrosible steels and alloys. For instance, in the production of synthetic urea it is necessary to use high-pressure columns of 200 mm wall thickness which work reliably under conditions of long-term affect of strongly aggressive environment.

The new techniques of electric-slag welding and automatic submerged arc welding makes it possible to fabricate thick-walled apparatus of plate clad with stainless austenitic steel.

In the Soviet Union has been developed a new principle of the production of thick, two and three-layer plate of large dimensions by rolling of heavy welded intermediates welded with the aid of the electric-slag welding technique.

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CALCULATION OF RADIANT HEATING SURFACE WITH REGARD TO THE PROPERTIES OF TUBING FOR TUBE FURNACES

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The critical evaluation of the known methods for the calculation of radiant heating surfaces of modern tube furnaces with regard to the properties of the employed technical material is dealt with.

The maximum overall stress of the technical material with regard to the most important influence factors (internal pressure and temperature difference in tube plate), in particular, for steel at high and low temperatures, is established.

The suggestion is explained how the distribution of temperature in the tube plate, conclusive for thermal stress in the tube, can be established with regard to the diameter of the tubes and their arrangement in the wall.

The calculation of the influence of so-called reflectors in circular furnaces is given.

Reference to electronic calculation of tube furnaces is made as a promising possibility how to increase the productivity of labour and precision as well (explained on hand of an example of pressure loss calculation at partial evaporation of the products).

TECHNOLOGICAL PROBLEMS OF THE PRODUCTION OF NICKEL
BASED ALLOYS

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The production of wrought alloys on the basis of nickel
with a high content of chromium, molybdenum, tungsten and/or
other elements meant for use as anticorrosive, or refractory,
or heat-proof materials, posses a series of technical problems.
Alloys produced in electric arc furnaces under admission of air
show in the cast structure of their ingots line segregations of
carbides, nitrides and oxides, which deteriorate their workabi-
lity. This can be forestalled to a certain extent by casting
the ingots under a protective atmosphere. The introduction of
the vacuum technique which yields a much cleaner material,
with a considerable dispersion of line segregations and increa-
sed plastic qualities, constitutes an important advance in the
production of these alloys. The range of optimum forging tempe-
ratures is not too wide and diminishes with the increasing com-
plex character of the alloy.If we succeed in breaking up the
cast structure of the ingot at the beginning of plastic defor-
mation, the further process of working is free of trouble. Due
to the high resistance to scaling loss, only an insignificant
layer of scale forms during working in the open air, so that
the surface temperature of the wrought ingot drops comparative-
ly quickly and, owing to the thermal conductivity, very slowly
gets balanced with the temperature of the centre of the ingot.

A METHOD OF CALCULATION OF TRANSIENT HEAT CONDUCTION PROCESSES

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This method may be estimated as something intermediate between the finite differences method (Binder-Schmidt) and the exact method, viz. finite differences are applied in space, and differentials in time. The method is to be applied if isothermal surfaces are known a priori. The temperatures on each surface are solutions of a system of linear differential equations of first order. The system, as a rule, may be replaced by one linear differential equation of an order not higher than the number of considered isothermal surfaces.

The method may be applied in various cases of transient conduction including the cases of variable material properties (as conductivity, thermal diffusivity etc.), internal heat sources, melting and freezing. The method is also useful in problems of heat convection and other problems of mathematical physics.

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EQUIPMENT FOR CONTINUAL PRODUCTION OF POLYETHYLENE

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In the research institute of Budapest a continuously work-
ing reactor for the production of polyethylene was developed in
scape of normal experiments.The capacity of the equipment is 10
kg/h of dry residue.

The designe of this reactor working under pressure requi-
red a new technique of construction.Some methods of supporting
titantetrachloride and Al-alkyl catalysators and ethylene were
found.First,after solving some problems it was possible to pre-
vent the settlement on the reactor-wall.A reliable and regula-
tenable process of the output device is very important for the
safety of operation.The extraction device is hydraulic opera-
ted.It ensures the safety and non-explosivness of the operation
and is easily to handle.The device enables a continuously off-
take of the final product from the reactor and allow to regula-
te the off-taken amount and in certain limits also the content
of dry residue.

The equipment was tested for some months.The paper deals
with the experiences made in this testing-run and with the pro-
blems of planning and designing.

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TUBE BRIDGES IN CHEMICAL PLANTS

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The fundamental condition for an economical construction of tubes is the correct decision of the way and the advantageous laying of tubes of various diameter with regard to the inclination, side lines etc. For plants of the Hungarian chemical industry a new set of light tube-bridges was proposed where the tubes are layed horizontally abreast and in calculations they are considered only as a statical weight and not as a dynamical one. The bridges are supported either by steel supports, by fixed supports from reinforced concrete of X-shape etc. The specifical local conditions will of course nevertheless require special designs of bridges.

It seems to be advantageous that tubes of a large diameter, connecting the plant equipment are constructed as a self-supporting design. In this case the tubes have also a statical purpose. By larger bridges they are included into the system of strenght of the supporting device. By dimensioning light tube bridges of a great lenght we must consider special items. In most cases a explanation of the vibration and aerodynamic stability is necessary, which may request a special design.

PRACTICAL ASPECTS OF SPRAYING PASTY SUBSTANCES

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The technological parameters of spraying were determined on a drying apparatus constructed on the basis of data from the literature and own experience. For the mechanism of a pneumatic sprayer of pastes, if need by its optimum working conditions, to be established, measurements at both low and high temperatures were carried out with an experimental sprayer. Measurement at low temperatures involved, above all, the quantities of air and substance. In order that the optimum spraying parameters might be established, two out of three parameters were kept constant (air pressure, size of air gaps, area of air-exit hole and area of exit hole for substance to be sprayed). The third parameter was subjected to changes: at the same time the size of the particles (spectrum) weight distribution, angle of deflection, etc. were measured.

Experimental drying was carried out with 40% dihydrochloritic and chalk pastes. It was found that by means of a drying plant, the final values of moisture can be obtained which do not reach even one per cent. In either substance the final product was also microscopically examined.

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NEW FILTER METHODS FOR FUEL,LUBRICANTS AND COOLING LIQUIDS

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The subject of the paper is a new filtration system for the filtration of fuel,lubricants and cooling liquids for Diesel motors,turbines,compressors,hydraulic equipment,etc.The efficiency of the described magnetic automatic filter is much higher than the efficiency of the known slot and sieve filters.The new kind of filtration do not exclude the use of aditive admixtures.

The filtration equipments are made for the passage of 5 - 10 000 l/min.They are mounted without a by-pass equipment,for the efficient removal of sludge enables a long-term operation; the magnetic automatic filters with an output of 50 - 1800 l/min have an efficiency of more than 98%.

The use of this filters enables a more quality processing of the surface and minimizes the wasting of the machine parts.

The filter perfectly removes the ferromagnetic and nonmagnetic parts from the liquid.

Using this filter one may obtain considerable savongs.

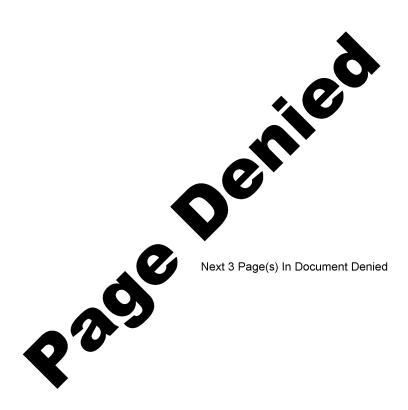## SLIGHTLY OSCILLATION IN BEARINGS OF HIGH-SPEED MIXER SHAFTS

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Projection Institute for Chemical Plants

Budapest, Hungaria

In equations, by which the critical revolutions are de-
termined, the springing of the bearing is added to the con-
stant of elasticity of the mixer shaft. This elasticity is not
constant, but depends on the loading of the bearing, respecti-
vely, on the end of the mixer shaft.

By means of the calculation of the minimum of function we
are able to determine the optimum distance of the bearings. By
locating a shaft with a great distance of the bearings, the
bearing of the shaft may in the constant elasticity of the
springing of ball bearings reach an amount of 4-15% in depen-
dence of the loading of the end of the shaft and in relation
of the free length of the mixer shaft to its diameter. If the
distance of the bearings is smaller than the optimum, this
value may reach even 30-90%, at larger distances it may be
neglected.

If an air or an turbine mixer is in practice statically
and dynamically in full balance, the relation of the free
length and the diameter of the shaft reach utmost 35. The
correspond distance of the bearings is between 20-30% of the
free length. In this cases the springing of the bearings ob-
tains about 6-8%.

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AN AUTOMATIC UNIT CHROMATOGRAPH

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An automatic unit gas chromatograph for the control of con-
tinuous technological processes operations with periodic
programmed sampling of a constant volume of the mixture
to be analyzed is described. The apparatus analyzes gas
mixtures up to temperatures of $50^{\circ}C$. An electropneumatic
rating dosing mechanism is synchronized with a switching
system for separation of water or higher boiling fractions
from the analytically important components. Detection is
by a highly sensitive heat conductivity cell. The sensiti-
vity can be controlled in 8 ranges by an attenuator.

The analysator is operated by a schedule panel. The proper
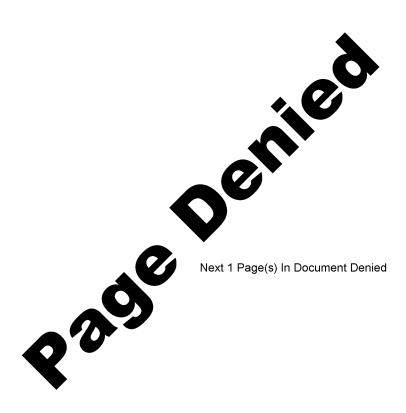chromatograph is an all-metal movable panel.

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THE UTILIZATION OF MEASURING SYSTEMS AND AUTOMATIC COMPUTERS IN
THE CONTROL OF PRODUCTION PROCESSES

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The author describes the utilization of measuring and data
handling systems in the control of petrochemical processes. The
proposed system enables the control of the processes of produc-
tion and technology, the performing of raw material, energetic
and product balances, the automatic signalling and logging of
failures, the periodic registering of parameter values in forms,
the punching of tapes and the preparation of the process optima-
lization, by using the automatic computer Elliot 803, which is
part of the information system Panellit 609.

In fulfilling these tasks the requirements upon the information
system have been defined and the suitability of the feelers examined.
The dependence of the output signal upon the measured quantity has
been checked and methods of linearization proposed. The mathematical
relations with regard to the correction of parameters, balance cal-
culations and computer program have been defined. The required ope-
rational time of the computer and the capacity of the memory have
been calculated on base of the fixed program.

In the first stage of application of the information system the
necessary data on the technological process will be obtained. The
next stage will be the utilization of the system for the process
optimalization, in that the computer will control the required values
of the hitherto independently operating controllers on ground of the
given control algorithms.

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IONIZATION CHAMBER AS CONTINUOUS GAS AND VAPOUR ANALYSER

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The distinctive features of a gas and vapour analyser are described. Using an encapsulated radioactive isotope /Sr^{90} - Y^{90}/ as the ionisation source, this analyser actually operates as a gasfilled ionisation chamber with variable gas filling and constant β-ray source. A special design of a twin ionization chamber in compensation arrangement has been achieved. Theoretical studies of some factors affecting the probe output signal are discussed. Results obtained are compared with measured values.

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MEASURING OF MATHEMATICAL MODELS FOR CHEMICAL EQUIPMENT

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Chemical Engineering Works
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A mathematical model for chemical equipment and its various types is defined. The valorization of measuring methods is used to determine the mathematical models of chemical equipment for automation. The presumptions and attainable results of measurement with statistic methods are described.

The chemical equipment is assumed to be a system with several inputs and outputs and is linear in the close surrounding of its process conditions. This system is expressed for each output value in a mathematic blockdiagram with all inputs and one output. For determining the relations between all inputs and one output, regression and correlation analysis is used. The mathematical blockdiagrams for both types of analysis are compared with each other, and it is shown that correlation analysis is more general than regression analysis, which may be derived from correlation analysis.

NUMERICAL CONTROL CASE UNITS

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Basic technical parameters of case units designed for numerical control of machine tools are described.

The possibility of their application in chemical industry is discussed and compared with some other systems of numerical control.

In the conclusion there are demonstrated some function parts realized by the help of the described case units.

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CONTRIBUTION TO THE CONSTRUCTION OF INSTRUMENTS BASED ON THE PRINCIPLE OF HEAT CONDUCTIVITY

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Instruments based on the principle of heat conductivity are insensitive to vacuum changes in the range of 1 to 10^{-3} kg/cm^2. This range may be increased up to atmospheric pressure by a constructional change of the chamber which brings about convection in the chamber, which is pressure-dependent. In order to obtain a regularly rising calibration curve, conductivity and convection must overlap. This is reached by increasing the feed current and chamber diameter.

Transition states of the instrument depend on the heat capacity values of the heating element and chamber, and in their construction zero stability of the bridge and reliability must be respected.

When fixed resistances are used in the bridge arms, zero stability depends on the feed current, temperature of environments and gas flow. These influences may be eliminated or largely decreased by suitable construction of the chambers and serio-parallel wiring of resistances.

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SMALL DATA-ACQUIRING CENTRAL MU-50-E

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A data acquiring central for 50 positions has been developed
for measurement and experimental operation of chemical equipment.
The input signals are direct current voltages in the range of 10 mV
to 2 V. It is possible to programm a number of input ranges and
linearisation types. Transforming from voltages to digits is done
by an electronic transducer at a rate of 1 transformation in 3 msec.
Numbers in the 8:4:2:1 code are transformed to the codes of a typewriter
or a display table, and are registered or displayed. The typewriter
registers data in a formular and marks data which are out of range
by red type and + or - signs, according to which limit has been over-
stepped.

The central is easily transportable, and no further equipment
is necessary for its installation except cables. The break-down
signalisation circuits are simlified. By connection of adaptors the
central may be extended to include a memory of break-down states,
including light signalisation in a scheme of the plant. Additonal
equipment may be used to extend the central to two-point regulation
and rapid registration of two selected operational data, which is
necessary for evaluation of the process by statistical means.

The central is being tested and prepared for the first
measurements in chemical plants.

IMPROVEMENT OF THE STATISTIC CHARACTERISTICS OF A SULPHURIC
ACID PLANT BY AUTOMATIC CONTROL

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An attempt is made to calculate preliminarily the effect
of automatic control on the improvement of the mean values of
main characteristics of a sulphuric acid plant. Mean conversion
values of SO_2 to SO_3 and the quality factor of SO_3 absorption
are considered. The calculation is carried out by use of sta-
tistico-dynamic considerations. The initial values are taken
from a registration band of the concentration of gas con con-
taining SO_2.

In accord with the assumption, that SO_2 oxydation takes
place on the last tray of the contact vessel adiabatically it
is possible to calculate the decrease of temperature oscillations,
and based on the relation between temperature and the SO_2 con-
version factor the latter may be calculated.

A similar procedure is employed in the calculation of the
SO_3 absorption quality factor. Stoechiometric considerations are
employed to calculate the effect of SO_2 concentration oscilla-
tions on the absorber acid concentration, taking into account
the fact, that due to absorber acid circulation the oscillations
are decreased by a factor of n. This factor is given by the ratio
of the circulating amount of acid and sulphur c.acid production
per time unit. The improvement of the quality factor is finally de-
termined by use of a graph of the relation of acid concentration
and absoption quality.

The numerical data obtained agree well with practical ex-
perience.

RESEARCH OF AUTOMATIC OPTIMALIZATION SYSTEMS, WHICH ASSURE
MAXIMUM TECHNICAL AND ECONOMICAL EFFECTIVITY OF PROCESSES

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Voronezh, USSR

Optimalization systems for the processes of ether hydration
and butylene dehydrogenation are described as examples of auto-
matic optimalization systems based on the principle of minimal
costs.

Technico-economical investigation of the hydration process
has shown, that the minimum of the generalised characteristic
of effectivity /the sum of costs and losses of the process/ cor-
respond to the optimum relation of qualitative characteristics.

In accordance with the aforesaid an optimalization system
has been realised. The structure of this system is described, as
well as technical data and experimental results.

For the process of butylene dehydrogenation an optimalization
system has worked out, which assures an optimal value of molar
dilution by minimalisation of the variable of divinyl production
costs, and an optimal value of the vapor-butylene mixture by sta-
bilisation of the divinyl yield.

An analysis of the systems described shows, that in a number
of cases the task of automatic optimalization is solved by the
use of custom-produced means of control and automation, without
use of costly analysers. Conditions are specified, under which
the aforesaid is valid.

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TO THE DISCUSSION ON THE METHOD OF SELECTING THE CONSTRUCTION TYPE OF HEAT EXCHANGERS WITH OPTIMAL CONTROL PARAMETERS

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The most essential condition in the automation of any industry is to obtain the highest possible degree of control precision in the control circuits.

According to accepted practice in the control of heat exchangers it has been proved that with the same regulators various values of the coefficient of maximum control precision may be obtained for various constructional types of the exchangers. A possibility of raising the control suspectibility of heat exchangers by proper construction of the apparatus is discussed.

Summarizing , one main point must be stressed: that the simplest method is the one which selects the optimum construction of the heat-exchanger. The results obtained are illustrated by experimental data. Transfer functions for the four constructional types of heat-exchangers, measured with the same thermo- and hydrodynamic parameters are shown.

NEW SYSTEM OF AUTOMATIC DIGITAL CONTROL

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A system of pneumatic digital and logical control, newly developed at the Chair of Automation and Control of the Department of Mechanical Technology of the Technical University of Praha is reported. The main pneumatic elements based on the principle of streaming, i.e. the control of a stream of air by another stream of air is reported. The elements work without any moving mechanic parts. The schemes of some logical functions are given /disjunction, conjunction, Sheffer's element a.o./ and some non-primitive schemes /memory, switching loops/ built up of the fundamental elements. Further results of tests and applications of this system are described.

The fundamental elements are miniature /volume 0,2 cm^3/ and are unusually rapid. It is supposed, that the new system of pneumatic digital control will replace even complicated electronic apparatus especially in the control of chemical processes, its reliability being far greater.

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ONE OF THE POSSIBILITIES FOR THE CONTROL OF COMBUSTION PROCESSES
CONTROL USING SIMPLE RADIANT HEAT FLOW METERS

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Optimal control problems of combustion processes in steady
states and in transient regimes require /in some cases/ the
use of special meters and measuring devices with digital com-
puters.

The heat exchange process in high efficiency furnaces is
for the most part achieved by radiation - therefore one of the
optimisation possibilities of combustion process is the appli-
cation of simultaneously acting heat flow meters.

In this paper the theory, dynamic characteristics, techno-
logy and performance experience of a simple radiant heat flow
meter are given and discussed.

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AUTOMATIC CORRELATOR

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An automatic correlator is described, equiped with pneumatic input for the range of 0,2 to 1,0 atm, electric input in the range of 0 to 10 V $\sim$ or direct connection to a resistance transmitter of 100 ohms. The correlator is fitted into the measuring instrument od the quantity which is to be studied. Continuous input signals are transformed to step-wise functions, represented by an analog voltage signal, which is then treated in the further elements. Signals may be delayed by introduction of the necessary values into a memory. The multiplication operation is carried out by a servomechanical multiplicator. Integration is carried out in such a way, that the analog voltage signal, which is proportional to the product, is transformed in an analog-digital transformer to a digital code, consisting of a series of pulses, whose number corresponds to the numerical value. Pulses are then added on the output summers. The correlator may be used to determine simultaneously 26 values of an autocorrelation function and 26 values of a mutual correlation function.

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DETERMINATION OF THE DISTRIBUTION OF POLES AND ZEROS FOR AN
INDUSTRIAL CONTROL LINE USING CORRELATION MEASUREMENTS.

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The determination of characteristics by correlation measure-
ments leads to an integral equation, from which the weight
function g/t/ of the control line is determined. Depending
on whether the measurement is accomplished in an open or
closed loop, the equation is chosen either in the form

$$\psi_{yx}(\tau) = \int_0^\infty g(\vartheta)\,\psi_{xx}(\vartheta-\tau)\,d\vartheta \qquad /1/$$

or

$$\psi_{yx}(\tau) = \int_0^\infty g(\vartheta)\,\psi_{xe}(\vartheta-\tau)\,d\vartheta \qquad /2/$$

       x - input signal of the control line
       y - output signal of the control line
       e - special reference input or disturbance

When the weight function is in graphic form, poles and
zeros of the corresponding response function are determined
directly. The paper presented describes for this case a
precise and an approximative procedure.

OPTIMALISATION OF PROCESSES IN THE PRODUCTION OF
SYNTHETIC ALCOHOL

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The production of synthetic ethylalcohol by hydration of
ethylene is characterized as a process well equipped with
measuring and control instruments.

Automatic control is carried out according to secondary
parameters instead of the main parameters - the quality
of products or semiproducts ; no optimalisation systems
are used.

This state is explained by a lack of suitable analysers,
but it is noted that analysers have been developed in the
past months, which will make it possible to construct opti-
malisation schemes.

The possibilities of optimalisation of the individual opera-
tions in the production of synthetic alcohol are considered
briefly :

Pyrolysis: either maximum ethylene yield from the raw
material supplied, or minimum costs for ethylene
separation

ethylene separation : maximum yield

ethylene hydration : maximum conversion and yield

rectification of the alcohol-water mixture: minimum losses,
minimum costs for the desired product quality.

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SOME OPTIMALISATION METHODS FOR PROCESSES OF THE CHEMICAL
INDUSTRY

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Deviations of controlled variables, which occur during operation
of chemical processing apparatus may be divided into three,
eventually four groups. The first includes deviations /of, for
instance, the flow or pressure of gases and fluids/ whose unit
function response has very short transition times. Control here
presents no difficulties. Deviations of the second group have
very short delay times with respect to the initiation time
/e.g. heat or mass transfer between gas and fluid/ Control here
is also easy. The third group includes such deviations /tempe-
rature in a distillation collumn/ whose delay time is long
with respect to the initiation time. PID regulators must be
employed in this case. The fourth group might include devia-
tions, whose delay time, compared to the initiation time, is
so long that stable oscillation may occur.

When a relation with a distinct extreme exists between two
parameters, use of an extreme regulator is suitable. Even
these instruments, however, cannot assure the control of com-
plicated technological apparatus.

In this case a mathematical description of the process must
be prepared and results of operational measurements must be
treated by statistical methods. Control is then carried out
by computers. Control by computers may be continuous or by
pluses, depending on the dynamics of the controlled object.

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NEW TYPES OF INFRARED ABSORPTION ANALYSERS DEVELOPED IN CZECHOSLOVAKIA

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New types of infrared absorption analysers for gases and fluids have been developed in the past months in some Czechoslovak laboratories. The instruments have novel arrangements with new constructional elements and are suited for application in various industrial and scientific fields.

New infrared analysers are described, having positive and negative filtration and using the deviation or compensation method of measurement, together with arrangements suiting them for use in media with danger of explosion.

The results achieved with these instruments and further possibilities of their application are described.

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DIGITAL CONVERTER METRA NR 10

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A compensating analog-digital converter type NR 10 has been developed in the Metra Works of Blansko, one of the factories concerned with development and production of digital instruments. The converter is designed for precise measurement of direct-current voltages in digital form, as well as for use in data-acquiring equipment for measurement in plants. The minimum voltage range is 1,0 V, precision 0,1 %, conversion time 15 ms. It is designed exclusively with transistors, units are built on interchangeable plates of standard dimensions with printed circuits. All parts are of Czechoslovak manufacture. The instrument can also be used in the reverse function, as a digital-analog converter.

COMPLEX AUTOMATION AND PRINCIPLES OF THE DESIGN OF SYSTEMS
FOR AUTOMATIC CONTROL IN CHEMICAL PROCESSING PLANTS

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Together with work dealing with the automatic stabilisation
of technologic processes, new opinions have been formed in the last
years with respect to the automation of chemical plants, and work has
been started whose aim was complex automation and optimalisation of
plants as well as whole factories.

Systems of automatic control and the principles of their
design are described. Such systems have a three-stage structure.

Among problems occuring in the design of automatic control
systems, the mathematical description of processes and plants and the
construction of algorithms for their control are described in the first
place. Further equipment and machines for data processing are classified
and their application and use are described. The necessary characteristics of such a system of data processing equipment are described in
detail: capacity, range and rate of data acquisition and compution,
information detectors, reliability of the system etc.

Finally problems of the reliability of automatic control
systems are analysed.

ON THE PROBLEM OF THE CLASSIFICATION OF INDUSTRIAL
PROCESSES AND IMPROVEMENT OF THE CONTROLABILITY OF EQUIPMENT

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The development tendency of passing from automation of objects
to complex automation, i.e. the passage to automation on a broad
basis and the introduction of progressive production processes
connected with this, will lead to the necessity of unification of
equipment for automatic control as well as of classification of
technological equipment which is used in various branches of industry.
Due to this classification it is possible to distinguish some groups
of equipment and whole schemes of production processes, containing
many larger numbers of single units. This will aid especially the
design of unified automation systems, and will show up such solutions
of design problems where typical units are used.

The abovenamed questions are opened for discussion in the
present paper, attention being directed before all to the necessity
of cooperation between technologists and automation specialists.
Especially dynamic optimum properties of controlled systems must be
taken into account when designing equipment.

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CONTROL PANEL REQUIREMENTS FROM THE PSYCHOLOGICAL STANDPOINT

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The authors summarize the results of widespread experimental research into the requirements which can be demanded of the design and arrangement of communicatory and control parts of machines, master control panels and exchanges from the aspect of psychophysiological hygienic conditions of work.

The main principles and directives relate to:

1. optimum legibility of figures, letters, scales and indicators,
2. arrangement of panels, assuring minimum errors in reading data,
3. the optimal distance for correct resolution of data,
4. conditions affecting visibility of control parts of machines in daylight and artificial light,
5. the effect of the number of information and reaction items on their correct resolution,
6. arrangement and shape of control buttons and levers.

From studies of free indicatory aimed movements of the arm, performed as reaction to reading signals, conclusions are made with respect to the influence of visual control and the arrangement and distance of control levers, buttons and switches on the precision of reactions. Conclusions as to the suitability of placing the main work interval for morning and afternoon shifts are supported by experimental results.

ON THE POSSIBILITIES OF AUTOMATION OF SMALL-SCALE
EXPERIMENTAL REACTORS

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Experiments are reported, whose aim was partial automation of small scale experimental reactors of 50 to 200 cm^3 contact volume. This small catalyst volume caused difficulties in measuring flow rates of gases and liquids at high pressures. After elimination of these difficulties of measurement appropriate control instruments were designed, which make faultless operation of the experimental reactors possible.

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SOME PROBLEMS AND TASKS OF INSTRUMENT ENGINEERING IN
DESIGNING COMPLICATED CONTROL LOOPS AND SYSTEMS FOR THE
SELECTION AND EVALUATION OF OPERATIONAL DATA

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The conventional design of control loops for the control
of complicated technological processes, and the arrangement
of the individual elements of the control chain and require-
ments as to their functional parameters are described.

Further main points of the paper are: the importance of
selection of a unified signal, especially with respect to trans-
fer of output information from detectors; requirements with
respect to the manner of signal processing in further instru-
ments; the principles of formation of central and polymorph
transfer systems; operational requirements on the vertical and
horizontal set-up of information and control systems.

AUTOMATIC COLORIMETRIC ANALYZERS

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Analyzers have been designed, able to measure and semi-
continuously record chemical data important for processing and
for product quality /e.g. feed water/. The instruments work
on the principle of automatic dosing of samples and reagents,
combined with colorimetric analysis and registration photocell
current, the resulting current being recorded or, by using
suitable wiring and relays, applied to automatic process control.

In a recent design, electromagnetic valves are replaced
by a simple yet very precise dosing device in which no moving
parts are used. In measuring liquids, an accuracy of o,1 to
0,5 % is achieved. The new type has been thoroughly tested in
the laboratory and is shortly to undergo operational trials.

The components of these analyzers are made of glass or
plastics by a simple moulding process. They can be assembled
in compact blocks particularly suitable for industrial use,
or else built up to perform any desired analytical or control
operations.

The way in which various types of the automatic analyzer
work will be illustrated on several examples.

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GENERAL ANALYTICAL DETERMINATION OF THE DYNAMIC PROPERTIES
OF RECTIFICATION COLUMNS

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The paper deals with the derivation of generally valid
relations (in the form of schemes and equations of signal circuits)
for the calculation of unit function responses of a rectification
column. The analysis of the dynamic properties stats from general
physical and physico-chemical formulas. The dynamics of three parts
of the system are treated separately: the column itself, the bottom
part (first tray with evaporator) and the head of the column (the
highest tray with condenser, cooler and condensate outflow).
Calculation of the column is based on calculation of its fundamental
unit - the tray - whose dynamic behaviour is described by a system
of nine simultaneous equations . The equations are linearised, i.e.
changed into differential equations and transformed. After simplifi-
cation three schemes of tray signal circuits are obtained, describing
the non-stationary states of accumulation, flow-rate of the liquid
phase and pressure. By combination of these schemes a scheme of the
tray is obtained, and further a scheme of the whole column. The
procedure for the calculation of the bottom and head of the column
is similar.

The scheme of the column is then simplified in such a way, as
to make possible either its modelling or the calculation of the unit
function reponse of the system. The results of this general analysis
have been tested on a full-scale column and it has been found , that
it agrees with measured results.

CONTRIBUTION TO THE ANALYSIS OF DYNAMIC PROPERTIES OF
TWO CONTROL SCHEMES FOR A RECTIFICATION UNIT

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Dynamic (and partially also static) properties of
two schemes of the control of a rectification unit are
compared. The first scheme is employed for control of the
composition of top or bottom products in tray-type recti-
fication units, working at atmospheric pressure. The
second scheme is proposed for the same application.

Basing on an analysis of the behaviour of control systems
at the top and bottom of columns for both control schemes,
hypothetic conclusions are drawn and compared with results
of investigations of a model realised by an analog computer.

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PRACTICAL EXPERIENCE WITH LOW-PRESSURE PNEUMATIC INSTRUMENTS

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After an introduction, dealing with the present state and advantages of low-pressure pneumatic control, some results are given on the operational testing of low-pressure instruments. This testing took place in three stages, or rather fields of application:

1. application of individual low-pressure instruments in "mixed" automation systems, especially in pneumatic-hydraulic systems

2. practical application of low-pressure teaching instruments and models

3. practical operation of low-pressure pneumatic instruments in industry (the metallurgical, chemical, energetic and paper industry)

Beside some specially interesting cases of application, as for instance optimum value control, the design of automation equipment for discontinuously working chemical processes is shown on a functional model.

PNEUMATIC COMPENSATING DETECTOR FOR THE MEASUREMENT OF VERY
SMALL FORCES

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The transformation of forces to the pressure of compressed
air in the detector is based on a principle different from that
employed in the pneumatic automatic control central, namely on the
principle of operation of flow-rate meters at constant overflow.

Five dimension types of membrane-less transformers of forces to
pressure of compressed air have been developed and built. All detectors
have shown exact linearity of the dependence of initial pressure on the
applied load. Maximum sensitivity was obtained for a detector with a
ball of 0,658 mm diameter, i.e. 3,4 mm w.c./mg load.

The membrane-less pneumatic detector is a body with a conical
channel (miniature detectors have a calibrated neck), in which a steel
ball acts as float. Channels for the feed reduction valve and the out-
put worming are bored in the body. The pressure of feed air is 1,1 to
1,4 Atm.

The instrument differs from existing transducers by the
following characteristics:

1. It has no elastic parts (membranes, silphones) which would introduce
   large errors into the precision of measurement of small forces.

2. It is possible to measure far smaller forces at the standard value
   of the output signal (0,2 to 1,0 Atm.) without additional amplifying
   elements, retaining the " compensating" properties.

3. The instruments is more sensitive and precise when measuring very
   small forces, of the order of magnitude of 1 dyne.

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AUTOMATION OF CONTACT PROCESSES

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The automation of catalytic (and especially contact processes) is one of the most important, and at the same time most complicated tasks of the automation of chemical plants. Two automation stages are differentiated: automatic stabilisation and automatic optimalisation of processes.

Temperature control is the most responsible and specific part of automatic stabilisation of contact processes. In the intensification of processes conditions may occur, in which the reactor, as object of temperature control, loses its stability.

Work done in the Institute, relating to control of the process of oxidation of benzene to maleic anhydride, has shown that a special control system, based on the second derivative of the parameter deviation may assure high quality of temperature stabilisation in the fluid catalyst bed, when the reactor operates in the non-stable region. This shown the possibility of great intensification of catalytic processes taking place under conditions near to isothermic conditions, the apparatus remaining simple and compact.

AUTOMATION OF CONTINUOUS AND DISCONTINUOUS DOSING OF
SOLIDS AND LIQUIDS

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A method of the fluidisation dosing of solids into
processing operations is described, as well as dosing liquid
components by volume with mutual ratio-binding of the dosing of
two and more components by weight and by time. Two main dosing
systems are treated: the continuous and the discontinuous system.
The continuous dosing systen is bases on the discontinuous method,
assuring precise mutual weight and time ratios, continuity being
by special equalising elements.

Both main systems are described in various variations, with
respect to capacities, various combinations with programming devices,
registration and summarisation.

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NEW TRENDS IN THE DEVELOPMENT OF CONTROL SYSTEMS FOR
UNIVERSAL APPLICATION

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The present state of the design of unit-type automation
instruments is described, and a systematic classification of
instruments for automation is proposed.

The unified signal is described as the main condition of
the design of automation systems based on single-function units.
The following are discussed in detail:

The unit pneumatic signal
The electric analog signal
The electric digital signal

Economic aspects of the design of automation systems are
further enumerated.

In the second part of the paper the universal control
system URS is described, which contains the following:

pneumatic part
electric analog part
electric digital part
hydraulic part
direct-action controllers

DYNAMIC PROPERTIES OF AN INFRARED ANALYSER

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The dynamic behaviour of an infrared analyser was investigated
under varying operation conditions, determined by the measuring
range of the analyser and by the flow-through volume of the analysed
gas sample. The values obtained were compared with dynamic properties
of the sampling system, needed for input of the analysed gas of the
required quality from the sampling point to the analyser. From the
comparison follows, that the delay of the analyser is usually far
less than the delay of the sampling system. The requirement of the
least possible delay of analysis leads to the primary neccessity of
suitable posotioning of the infrared analyser with respect to the
sampling point, and to a suitable design of the sampling system.

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THE PROBLEM OF CENTERED APPARATUS IN THE STABILIZATION OF CON-
TINUOUS PROCESSES

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The present paper investigates the question of filtration
of dynamic disturbances in apparatus with continual operation,
by means of centering some of the parameters in the course of
the working cycle.

Simplified equations are derived for some typical centering
processes, unit function responses and graphs of response pro-
cesses are set up. Based on the amplitude-frequency response,
the properties of filtration systems are studied. A table of the
results of problems investigated for the most often occuring cen-
tering systems is included: mixers, buffering capacities, etc.
Results given may be used for the design of apparatus under the
condition that the character of the disturbing effect is known.

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DESIGN OF CONTROL CENTRALS IN THE CHEMICAL INDUSTRY

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A review of the present methods of design of control centrals and panels in the chemical industry is given in the introduction. From this review follows, that at present control is carried out in the individual plants independently. Control systems are used, which make it possible to concentrate controlled and measured variables in one control panel, the controlled variables being set to pre-determined invariable, or corrected values.

It happens often that technologists, because of insufficient knowledge of the process prescribe control or measurements in cases, where on more detailed study of the problem these would be found unnecessary. Control panels thus become unnecessarily large.

Basing on analysis and experience with conventional control panels a new solution is proposed. Automation is in this case supposed to be common for a number of plants, with the possibility of correction of the set values by the use of a computer. The proposed solution aims at a decrease of the number of instruments and maintenance costs, together with increased reliability and easier control by personnel. A pneumatic system is proposed with a common central for more plants, concentrating all measured variables.

ON THE TRAINING OF HIGHLY QUALIFIED SPECIALISTS (PROCESS ENGINEERS)IN CHEMICAL PROCESS AUTOMATION

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Questions relating to the training of specialists for the field of chemical process control are discussed.

An orientation plan for the training of process automation engineers is described. This training should be directed to the solution of two sets of problems:

1. problems connected with the application of mathematical methods and compution techniques for the investigation and mathematical description of chemical processes,

2. problems, connected with the application of mathematical descriptions of processes for optimum design and control.

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POLAROGRAPHIC ANALYZERS

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The most exact polarographic inuicating electrode, the dropping mercury electrode, has besides its excellent properties some serious disadvantages which very often forbid its use in automatic, especially continuous, analyzers. It is the main reason why indicator electrodes with constant surface such as the mercury pool electrode, the platinum and gold electrodes or the carbon electrode and others have been often used. When using this type of indicator electrodes, the electrolyte must be intensively stirred either mechanically or preferently by bubbling a gas through it. If speaking only about advantages of these electrodes the larger current i.e. larger sensitivity may be mentioned in this connection.

Sometimes even a small change in experimental conditions may bring a substantial improvement of properties of the system as shown further on a special example of a cclometric analyzer.

Some examples of analyzers succesfully proved in long run operation are described in more detail in order to show the particular demands of some practically solved problems.

CONTINUOUS TITRATING ANALYSER

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An automatic titrating analyser has been developed for the control of the content of nitric acid in waste nitrating acid, working on the principle of potentiometric titration of nitric acid by ferrous sulphate solution in a medium of at least 85% sulphuric acid. The reaction is kept at the equivalence point by variation of the inflow of the titrating agent. The inflow volume of the titrating agent at constant vacuum inflow of the acid sample to be analysed corresponds to nitric acid content, and is registered by a registrating instrument.

The paper deals with a review of the design of the individual functional parts and an explication of the analyser design employed, consisting mainly of automatic control of weight inflow of the sample, the main titrating part with dosing of the titrating agent and of sulphuric acid, and an electronic block, including circuits necessary for automatic operation of the instrument.

The main results of work carried out up to now, as well as of tests carried out with the analyser are also given.

USE OF THERMISTORS IN THE LABORATORY

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The use of thermistors for accurate measurement and recording of temperature and temperature differences to $0,001^\circ$ C in the laboratory is described. The apparatus yields a linear temperature dependence. Three degrees of sensitivity can be used. The output signal of the measuring bridge can be amplified either by the recorder amplifier or by a separate transistorized amplifier with temperature stabilization. The apparatus was used to measure and record temperatures in thermal analysis of solutions, calorimetry, vapor tension of water and in thermometric titrations.

CONTINUOUS INFRARED ANALYZER WITH LIGHT DISPERSION

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A simple double-ray continuous infrared analyzer for liquids is described, equipped with optical compensation and light dispersion by a monochromator with NaCl prisma. The instrument is designed for the determination of one component in a multi-component mixture in chemical processes.

The design of the instrument and its individual parts /optics, amplifier, thermostating, etc./ is described. Experiences from practical use of the instrument are briefly summarized.

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AUTOMATIC GAS ANALYZERS, ESPECIALLY BASED ON GAS CHROMATOGRAPHY

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Principles and types of automatically working gas analyzers are given.

Gas-chromatographic analyzers from Czechoslovakia and other countries are shown and commented. Specific conceptions used in Czechoslovak GC monitors are described in detail. In connection with problems of correct analytical signal new Czechoslovak systems for time and maxima programming based on the comparison method are discussed.

SOLID SUBSTANCES ANALYSERS BASED ON THE PRINCIPLE OF
ABSORPTION AND BETA-RAY REFLECTION

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In our century the idea of semiautomatic and automatic
chemical analysis comes into practice. Besides spectral, electrical
and optical methods the radio-metric methods are also of importance.

For the determination of solid substances beta-ray reflection
was applied especially permitting the development of simple and
automatizable analytical methods without destruction of the sample.

The beta-ray reflection can also be used in the chemical
industry for the automatic check-up on correct dosing of raw materials,
in dressing and flotation of coal, for charging raw materials into
a blastfurnace.

The idea of absorption and gama-ray reflection is, on the
other hand, employed for the determination of the ash content in
coal and in the USSR a radio-metric automatic separator was built for
separating coals and ores from deads.

Automatic and semiautomatic analysers working on the basis
of absorption and beta-ray reflection will be descrobed.

The relevant diagrams, calibration curves and photographs of
the instruments in question are expected to show that radio-metric
methods make possible rapid and automatizable analyses without des-
truction of the sample.

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KOMPLEX ANALYSIS OF CHEMICAL PRODUCTION PROCESSES AS A CONDITION OF OPTIMAL COMPLEX CONTROL

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The complex analysis of chemical production processes is derived from analysis of the limiting conditions and from analysis of the mathematical, physical, physico-chemical, chemical and technical aspects of the process. Analysis of the process helps to attain production means corresponding to the superior production methods, without marked increase of costs.

The author deals with the economical aspect of automation and shows that the costs of automation equipment are at least equalled by other economical results following from automation of the process. The author proves his conclusions by two practical examples.

The author further compares the advantages and disadvantages of the various types of auxiliary energy used for the control signals and stresses the need of centralising measuring and control equipment.

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